The experiment of cooperative learning model type team assisted individualization (TAI) on three-dimensional space subject viewed from spatial intelligence

I Y H Manapa¹*, Budiyono¹ and S Subanti¹
¹Mathematics Education Department, FKIP, Sebelas Maret University
*Corresponding author: manuelmathematics@gmail.com

Abstract. The aim of this research is to determine the effect of TAI or direct learning (DL) on student’s mathematics achievement viewed from spatial intelligence. This research was quasi experiment. The population was 10th grade senior high school students in Alor Regency on academic year of 2015/2016 chosen by stratified cluster random sampling. The data were collected through achievement and spatial intelligence test. The data were analyzed by two ways, ANOVA with unequal cell and scheffe test. This research showed that student’s mathematics achievement used in TAI had better results than DL models one. In spatial intelligence category, student’s mathematics achievement with high spatial intelligence has better result than the other spatial intelligence category and students with high spatial intelligence have better results than those with middle spatial intelligence category. At TAI, student’s mathematics achievement with high spatial intelligence has better result than those with the other spatial intelligence category and students with middle spatial intelligence have better results than students with low spatial intelligence. In DL model, student’s mathematics achievement with high and middle spatial intelligence has better result than those with low spatial intelligence, but students with high spatial intelligence and middle spatial intelligence have no significant difference. In each category of spatial intelligence and learning model, mathematics achievement has no significant difference.

1. Introduction
Mathematics is one of the subjects, which is taught at every educational level. It is considered important not only for an academic purpose but also for student’s equipment in solving many problems related to the real life. Despite its important for students, mathematics is one of the most difficult subjects. If it is not seriously handled, it can make the student’s mathematics achievement to be low.

The national examination result is a mark of a low student’s learning achievement in all regions in Indonesia. An example for this case is the average of mathematics subject in national examination in Alor Regency in academic year of 2015 as much as 25.81, with the highest score of 75.0 and the lowest score of 0.0. When looking at the student’s distribution score, the students’ scores are in the range of 20.0 to 29.9. The student’s absorption capacity on the national examination also influences the low student’s learning achievement on mathematics. Student’s absorption capacity in Alor Regency in all tested subjects is considered as low; however, from some materials, three-dimensional space material has the lowest one. Student’s absorption capacity on that material is based on PAMER UN 2015 for science major in all high schools of Alor Regency. The student’s absorption capacity on
three-dimensional space material in Regency level is 14.94%, this result is lower than Province result of 28.04% or National result of 37.58%. This outcome means that there are 85.06% of students in Alor Regency that still have a difficulty in understanding three-dimensional space material.

There are internal and external factors which influence student’s learning achievement. One of the external factors is the learning method used by teachers. The learning method used by a teacher in a learning process should be able to facilitate students who have various abilities so that they can increase their learning achievement. However, in fact, teachers tend to use teacher-centered learning method so that the learning process becomes passive and student’s learning achievement is decreasing. Knowledge cannot be absorbed passively from the environment; instead it is arranged by someone as their interaction chain [1]. Therefore, teachers must apply learning method which prioritizes more on interaction among students. One of the learning methods which prioritize more on student’s interaction is the cooperative learning model [2]. Hence, the cooperative learning model can be used as an alternative solution to solve the problem as mentioned above.

Cooperative learning is a learning model that can stimulate cognitive activities, promoted higher levels of achievement and knowledge [3]. Cooperative learning facilitates student’s interaction during small discussions, in which student can actively listening to each other, sharing ideas, commenting constructively on others idea, accepting responsibility for one behavior, and making decisions democratically [4]. Cooperative learning refers to learning together in small groups to effect individual accountability and a common group goal [5]. In cooperative learning group; students work together to accomplish shared goals, students seek outcomes that are beneficial to all, students discuss material with each other, help one another to understand it, and encourage each other to work hard. Cooperative learning model is a learning model where students work in small groups to help, to discuss, to debate, to sharpen knowledge, and to fulfil the gaps in another student’s understanding. Cooperative learning model gives more space and opportunities for students to discuss, solve problems, create solutions, provide ideas and help each other’s [6]. The special characteristic of cooperative learning model marks the existence of group activities. However, not every cooperative learning model with group activities is categorized as cooperative learning model. There are five elements which differentiate student activities on cooperative learning model and student activities on another learning model. The differences are positive interferences, promotive interaction, individual accountability, interpersonal ability, and group processing [7].

In class teaching and learning process, teachers often find problems related to student’s condition with heterogeneous background. Therefore, teachers must find a way so that they can adapt to every different student condition. Cooperative learning model type Team Assisted Individualization (TAI), is considered to be the exact model to overcome this problem. The aim of TAI is to minimize the outcomes that appear during the learning process because of an individual difference [8]. TAI combines cooperative learning with individual instruction. In TAI, students firstly solve problems individually and then ask help from their teammates. This model emphasizes on the positive interdependence among students, their individual responsibility, face to face meeting, intensive communication, and group evaluation process so that the classroom management becomes more effective. TAI has eight elements, the elements are placement test, teams, teaching group, student creative, team study, fact test, team score and the whole class units [9]. The benefits of TAI are that teachers minimize the role of daily checking and organizing, teachers are spending at least most of their time in teaching small groups, teachers facilitate students in conducting the method because of its simplicity, teachers motivate students to learn given materials easily, accurately, and without cheating or shortcuts.

In addition to student external factor, student internal factor also supports student’s mathematics achievement. One of the factors is the student’s spatial intelligence. Spatial ability is important in the process of teaching and learning mathematics [10]. Spatial intelligence has a connection with student’s mathematics achievement [11].
Spatial intelligence can help students to solve problems in math such as geometry or non-geometry [12]. Spatial intelligence is an ability to recognize object shape precisely, to change an object in his mind and recognize the changing, to illustrate something or an object in his mind, and to transform it to be real [13]. Spatial intelligence mostly depends on the ability to illustrate shape and space from an object and to think about the shape [14]. There are five indicators to measure spatial intelligence. They are spatial perception, spatial visualization, mental rotation, relation, and spatial orientation. Spatial perception is an ability to observe an object which is placed horizontally or vertically. Spatial visualization is an ability to imagine or illustrate shape of an object whose parts have a change or displacement. Mental rotation is an ability to rotate an object quickly and precisely. Spatial relation is an ability to comprehend a shape of an object or pieces of it, and the relation between one and another of an object. Spatial orientation is an ability to find a self-guideline physically or mentally in something or oriented manner [15].

Every student has different spatial intelligence levels and it can influence their geometry understanding especially on three-dimensional space [16]. The problem concerning the three-dimensional space materials and student diverse intelligence can be minimized using the appropriate learning model. [17]. Based on the purpose of TAI, researcher hopes that this TAI model type can overcome the problem of student’s low mathematics achievement on three-dimensional space materials with student’s various spatial intelligence differences. Problem statements of this research are 1) on three-dimensional space materials, which mathematics learning achievement is better? Is it student whose use cooperative learning model or direct learning model? 2) on three-dimensional space materials, which mathematics learning achievement is better among students with high, middle, or low spatial intelligence? 3) on each learning model, which mathematics learning achievement is better among students with high, middle, or low spatial intelligence? 4) on each spatial intelligence category, which mathematics learning achievement is better, cooperative learning model type TAI, or direct learning model?

2. Methods
The type of this research is a quasi-experimental research with learning model and spatial intelligence as the independent variables, and learning achievement as a dependent variable. The study population are all 10th grade students of the Alor Regency NTT Province of 2015/2016 academic year. This study population consist of students from 15 high schools all over Alor Regency. This study uses stratified cluster random sampling technique to collect the sample. From that population, finally researcher took three high schools with high, middle, and low category, which then two classes are taken from each high school randomly. Finally, researcher got 161 students as a sample.

The data is collected by using documentation and test method. In collecting mid semester examination results, researchers used documentation methods which is assumed as the initial data, which then used to analyze initial data balance test by using a one-way Analysis of Variance with unequal cells. Aside from documentation test, researcher uses a test method to measure student learning achievement and student spatial intelligence. Before the use of this instrument, the content validity test has been done by mathematics experts for learning achievement test instrument and phycology experts for spatial intelligence. The researcher uses the content that passes validity test as a research instrument in which the instrument is tested and analyzed with the instrument requirements such as difficulty level, distinguishing power, and instrument reliability test. Hypothesis test is done by using the two-way analysis of variance with unequal cells whose design is $2 \times 3$ factorial designs. If the result shows $H_0$ is rejected, then there will be a further testing with Scheffe method.

3. Result and Discussion
Prerequisite test results show that normal and homogenous distributed sample has a balance test using a one-way ANAVA with unequal cells. After the balance test, researcher found that both of the study groups are in balance. Because the prerequisite test has met the results, then researchers do a hypothesis test. Table 1 shows the hypothesis test results using a two-way ANAVA with unequal cells.
Based on the two-way analysis of variance with unequal cells, it is found that learning model and spatial intelligence are $F_{obs} > F_{a}$ resulting in $F_{obs} \notin DK$, and on the interaction between both independent variables, researchers found that $F_{obs} > F_{a}$ resulting in $F_{obs} \notin DK$. Therefore, the conclusion is that 5% level of significance of rejected $H_{0A}$, $H_{0B}$, and $H_{0AB}$ means that:

1. There is a different effect among learning models on student’s mathematics learning achievement.
2. There is a different effect among spatial intelligence on student’s mathematics learning achievement.
3. There is interaction between learning models and spatial intelligence on student’s mathematics learning achievement.

### Table 1. Summary of two-way analysis of variance with unequal cells of the research data

| Variation Source | JK   | DK   | RK   | $F_{obs}$ | $F_{a}$ | Test Decision |
|------------------|------|------|------|-----------|--------|---------------|
| Factor A (learning model) | 593.75 | 1    | 593.751 | 5.19734  | 3.054  | $H_{0}$ is rejected |
| Factor B (spatial intelligence) | 14160.89 | 2    | 7080.45 | 61.978   | 3.054  | $H_{0}$ is rejected |
| Interaction      | 721.59 | 2    | 360.797 | 3.1582   | 2.43   | $H_{0}$ is rejected |
| Errors           | 17707.40 | 155  | 114.241 |          |        |                |
| Total            | 33183.63 | 160  |        |          |        |                |

This Table 2 shows the summary of student’s average on each learning model and spatial intelligence based on the result of double comparison test.

### Table 2. Summary of students average on learning model and spatial intelligence

| Learning Model (Factor A) | Spatial Intelligence (Factor B) | Average of Marginal Bar |
|---------------------------|---------------------------------|-------------------------|
|                           | High                            | Middle                  | Low         |
| TAI                       | 70.42                          | 58.94                   | 41.5        | 59.16       |
| Direct                    | 61.57                          | 54.10                   | 43.27       | 52.25       |
| Average of Marginal Column| 66.66                          | 56.52                   | 42.52       |

Based on the result of the two-way ANOVA test with unequal cells, researchers found that $H_{0A}$, $H_{0B}$, dan $H_{0AB}$ are rejected, so researchers use Schefte’s method with a 5% level of significance to do a double comparison test. Double comparison test among bars, columns, and cells are on the same bars, while cells are on the same columns. The summary of double comparison test can be seen in Table 3 and Table 4.

3.1. **Double Comparison Test between Lines**

### Table 3. The Summary of the average comparison between lines of research data

| No | $H_0$    | $F_{obs}$ | $F_{a}$ | Test Decision |
|----|----------|-----------|---------|---------------|
| 1. | $\mu_1 = \mu_2$ | 0.86240697 | 6.0678 | $H_0$ is rejected |

Based on double comparison test between the lines with a learning model as independent variable, researchers found that $H_{0A}$ is rejected. Therefore, to draw a conclusion, researchers need to look at Table 2, especially on the marginal average bars column. The marginal average of cooperative learning model type TAI is 59.16 and a direct learning is 52.25, so the conclusion is that cooperative
learning model type TAI results in better mathematics learning achievement than the direct learning model. Aside from this finding, cooperative learning model type TAI is in line with the more communicative learning process that enables students to share information between one another so that the learning atmosphere is more conducive and students can comprehend materials better than the direct learning whose activities tend to be passive.

3.2. Double Comparison Test between Columns

Table 4. The Summary of the Average of comparison between Research Data Columns

| No | $H_0$ | $F_{obs}$ | $F_\alpha$ | Test Summary       |
|----|-------|-----------|------------|--------------------|
| 1. | $\mu_1 = \mu_2$ | 21.705 | 6.108 | $H_0$ is rejected |
| 2. | $\mu_1 = \mu_3$ | 156.019 | 6.108 | $H_0$ is rejected |
| 3. | $\mu_2 = \mu_3$ | 39.117 | 6.108 | $H_0$ is rejected |

Based on the double comparison test between columns with spatial intelligence as an independent variable, researchers found that $H_0$ is rejected. Therefore, to draw a conclusion, researchers need to look at Table 2, especially in the columns of marginal columns average. The marginal average for the high spatial intelligence is 66.66, marginal average for middle spatial intelligence is 56.52, and marginal average for low spatial intelligence is 42.52. By using these data, researchers conclude that student’s mathematics achievement with high spatial intelligence is better than that of low spatial intelligence, while student’s mathematics achievement with high spatial intelligence is better than that of middle spatial intelligence. Spatial intelligence really helps students in learning three dimensional space materials. There is a significant connection between special intelligence with student’s mathematics learning achievement. This statement means that the higher the spatial intelligence is, the higher the potential students have in gaining a better mathematics learning achievement than any other students with lower spatial intelligence.

3.3. Double Comparison Test between Cells

Table 5. The Summary of Comparison Average between Bar Cells of Research Data

| $H_0$ | $F_{obs}$ | $(ab - 1)F_\alpha$ | Test Decision       |
|-------|-----------|-------------------|--------------------|
| $\mu_{11} = \mu_{12}$ | 14.59 | 11.362 | $H_0$ is rejected |
| $\mu_{11} = \mu_{13}$ | 107.69 | 11.362 | $H_0$ is rejected |
| $\mu_{12} = \mu_{13}$ | 60.75 | 11.362 | $H_0$ is rejected |
| $\mu_{21} = \mu_{22}$ | 5.52 | 11.362 | $H_0$ is not rejected |
| $\mu_{21} = \mu_{23}$ | 44.39 | 11.362 | $H_0$ is rejected |
| $\mu_{22} = \mu_{23}$ | 12.38 | 11.362 | $H_0$ is rejected |

For students with cooperative learning model type TAI, the average with high spatial intelligence is 70.42, students with middle spatial intelligence is 58.94, and students with low spatial intelligence is 41.5. Therefore, researchers conclude that on learning model type TAI, students with high and middle spatial intelligence have better mathematics learning achievement than those of lower spatial intelligence; however, students with high spatial intelligence have better mathematics learning achievement than those with middle spatial intelligence. On cooperative learning model type TAI, the
Different level of student's spatial intelligence can be minimized. By the existence of group activities, students with higher spatial intelligence can help and complement the other student’s needs with lower spatial intelligence. If there is no obstacle during the learning process, the learning achievement of three intelligence categories must not have significant difference. In fact, there is still domination from students with high spatial intelligence during discussion process, so that students with the other intelligence are only piggybacking on students with high spatial intelligence, and the discussion becomes unbalanced. This thing results in a better student’s learning achievement for those who have high spatial intelligence than those of other spatial intelligences.

On students with direct learning model, researchers found that the average of students with high spatial intelligence is 61.57, with middle spatial intelligence is 54.10, and with low spatial intelligence is 43.27. Therefore, this study concludes that on direct learning model, students with high and middle spatial intelligence have the same mathematics learning achievement, while students who have high and middle spatial intelligence have better mathematics learning achievement than those with low spatial intelligence. This result means that a direct learning model doesn’t really motivate high spatial intelligence students to acquire an optimal learning achievement. A direct learning model cannot facilitate high spatial intelligence students to explore their abilities and tend to be boring for students so that the materials given by teachers cannot be understood well. These findings cause student’s learning achievements with high and low spatial intelligence have no significant difference. The same thing happens to students with low spatial intelligence. The lack of student’s activities causes students with low spatial intelligence to be passive and cannot understand materials given by teachers maximally that leads to lower learning achievement compared to students with high and middle spatial intelligence.

3.4. Double Comparison Test between Cells.

Table 6. The Summary of the Average of Comparison between Column Cells of Research Data

| H₀         | F₁₁ = F₁₂ | (ab – 1) F₁₂ | Test Decision |
|------------|------------|--------------|---------------|
| H₀         | 11.05      | 11.362       | H₀ is not rejected |
| H₀         | 1.94       | 11.362       | H₀ is not rejected |
| H₀         | 0.38       | 11.362       | H₀ is not rejected |

Double comparison test result between column cells for all spatial intelligence in the F category for each learning model leads to the test decision of rejection of H₀ (Table 6). Therefore, researchers conclude that the student’s learning achievement on high, middle, and low spatial intelligence category has no significant difference between the cooperative learning model type TAI and direct learning model. On student high spatial intelligence category with cooperative learning model type TAI, has average of 70.42, while students with direct learning model has an average of 61.57. On middle spatial intelligence category, students with cooperative learning model type TAI have an average of 58.94, while students with direct learning model have an average of 54.10. On low spatial intelligence, students with cooperative learning model type TAI have an average of 41.5 while students with direct learning model have an average of 43.27. There is a difference of marginal average between cooperative learning model type TAI compared to direct learning model on each spatial intelligence category. However, the result of double comparison test shows that the student’s learning achievement of spatial intelligence in every learning model is not that different. This result occurs probably because of the problem occurred during the research process. Cooperative learning model type TAI is supposedly giving a positive effect on each spatial intelligence category so that it can contribute to a better learning achievement compared to the direct learning model. However, on the research place, cooperative learning model TAI is rarely applied that causes this learning model tastes new for students. Therefore, students need to adjust with this learning model. Consequently, there is a domination of students with a high spatial intelligence during the learning process which causes students in middle and low spatial intelligence to be passive during the
discuss. This reason causes the average of student’s learning achievement on cooperative learning model type TAI has no difference compared to the direct learning model.

4. Conclusion
The findings of this result are (1) cooperative learning model type TAI produces a better mathematics learning achievement than the direct learning model; (2) students with high spatial intelligence have better mathematics learning achievement than those with middle and low spatial intelligence, furthermore, students with middle spatial intelligence have better results than those with low spatial intelligence; (3) on the TAI learning model, student’s mathematics learning achievement with high and middle spatial intelligence is better than those with low spatial intelligence. Meanwhile, students with high spatial intelligence have better mathematics learning achievement than those with middle spatial intelligence. On direct learning model, student’s mathematics achievement with high and middle spatial intelligence is better than those with low spatial intelligence. Meanwhile, students with high and middle spatial intelligence have the equal mathematics learning achievement; 4) on students with high, middle, and low spatial intelligence, the student’s mathematics learning achievement is the same for both TAI learning model and direct learning model.

Some suggestions based on the research are (1) teachers are suggested to use student-centered learning model so that the learning process is not passive and boring. In choosing a learning model; (2) teachers are suggested to look at student internal condition (student spatial intelligence) so they can decide a learning model that facilitates students in maximizing their ability; (3) to maximize learning achievement with cooperative learning model, it is better for teachers to control the discussion process to minimize the domination of clever students so that students with all members of the group can participate actively.

References
[1] Schunk, D H 2012 Teori-Teori Pembelajaran: Perspektif Pendidikan (Jakarta: Pustaka Pelajar).
[2] Altun S 2015 International Eletronic Journal of Elementary Education 7 45
[3] Tran V D 2012 International Education Studies 5 87
[4] Gillies R M 2016 Australian Journal of Teacher Education 41 39
[5] Adeneye O A, Awofala, Abayomi A, and Arigbabu A Acta Didatica Napocensia 6 1
[6] Zakaria E, Chin LC, and Daud Y 2010 Journal of Social Science 6 272
[7] M Huda 2011 Cooperative Learning Metode, Teknik, Struktur dan Model Penerapan (Yogyakarta: Pustaka Pelajar)
[8] Slavin R E 2005 Cooperative Learning Teori Riset dan Praktik (Bandung: Nusa Media)
[9] Tinungki G M 2015 Journal of Education and Practice 6 27
[10] Turgut M and Yilmaz S 2012 International Journal of Instruction 5 5
[11] Kondor R N 2017 Visual-spatial Ability in STEM Education Transforming Research Into Practice ed M S Khine (Switzerland: Springer International Publishing) chapter II pp 35-58
[12] Lowrie T, Logan T, and Ramful A 2016 Spatial Reasoning Influence Student; Performace on Mathematics Taks (Australia: Proc. 39th annual conference of the Mathematics Education Research group of Australasia)
[13] Gardner H 2003 Kecerdasan Majemuk ed Sindoro A (Batam: Interaksra)
[14] Yaumi M. 2012 Pembelajaran Berbasis Multiple Intelegences (Jakarta: Dian Rakyat)
[15] Maier P H 1998 Spatial Geometry and Spatial Ability – How to Make Solid Geometry Solid? In Elmar Cohors-Fresenborg, K. Reiss, G. Toener, and H.-G. Weigand, editors (Osnabrueck : Selected Papers from the Annual Conference of Didactics of Mathematics 1996) p 63–75.
[16] Jakubowski E 2009 International Journal of Mathematical Education 40 997
[17] Susilawati W, Suryadi D, and Dahlan A J 2017 International Electronic Journal of Mathematics Education 12 155