Mathematical spatial and disposition ability through the wingeom application

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Abstract. The purpose of this study was to determine the increase and achievement of mathematical spatial abilities based on high, medium, and low categories and to find out the attitudes of students towards learning through Wingeom. This research is a quasi-experimental study conducted on class IX students of one junior high school in Bandung Regency. Based on the data gain and posttest data it was stated that there were differences in the significant increase in mathematical spatial ability in both the PAM (pengetahuan awal matematika) category (early mathematical knowledge) and overall experience differences with the high mean. In general, students respond well to the use of learning media through the Wingeom application with an analysis of 2.76. Thus learning through the Wingeom application can be used as an alternative to improve the spatial abilities and mathematical dispositions of students.

1. Introduction

National Academy of Science [1] states that every student must try to develop abilities and spatial sensing that are very useful in understanding relationships and properties in geometry to solve mathematical problems and problems in everyday life. Thinking structured, systematic and procedural is a competence built on mathematics [2]. Nemeth in his research revealed the importance of real spatial abilities that are very much needed in the engineering and mathematical sciences [3]. Three things that cause formal geometrical capabilities do not develop, namely the difficulty in forming real construction that is needed accurately, the assumption that to paint geometry requires a long time, and most students have difficulty in proving Euclid's basic geometry concepts and studying such evidence is not useful [4]. Furthermore, Kariadinata [5] suggests many geometry problems that require visualization in problem-solving and generally students feel difficulties in constructing geometric spaces.

Spatial ability is the ability of students to imagine, compare, guess, determine, construct, represent, and find information from the visual stimulus of an object in the spatial context. Indicators of spatial ability include: stating the position between the elements of building space; imagine the shape or position of a geometric object and investigate a geometric object. High spatial ability subjects also had less difficulty with object complexity and the hidden properties of an object [6]. Based on the preliminary results in one of the schools in Bandung Regency, the highest score was 50 and the lowest value was 15. Overall, the values obtained by students were still below the standard. With an average
value of 43.18 from a range of values from 1 to 100. Some difficulties experienced by students showed that spatial abilities and mathematical dispositions were still low. Students' mathematical disposition can be seen from the students' desire to change strategies, reflect, and analyze and to obtain a solution. Students' disposition towards mathematics can be observed in class discussions. For example, how much the students want to explain the solutions they obtain and maintain the explanation.

The results of the study [7] concluded that at this time, students' mathematical power and disposition had not been fully achieved. It can be seen from this finding that there is an indication of students' low mathematical dispositions. Furthermore, the results of the research conducted [8] found that of 297 junior high school students as the research sample obtained 58% were classified as having low mathematical dispositions. Computer technology has become a very rapid development which can be used in learning. Wingeom's program is one of the dynamic computer software for geometry topics designed to support geometry learning, both two-dimensional and three-dimensional. This program can help to develop dimensional geometry and help visualize geometric concepts clearly. Spatial ability in this study is the ability of students to imagine, compare, guess, determine, construct, represent, and find information from the visual stimulus in the context of space. The spatial ability indicators measured in this study are; (1) State the position between the elements of building space; (2) Imagine the shape or position of a geometric object; (3) Investigating a geometry object. To improve mathematical disposition, the teacher must be able to provide a good mathematical learning experience to students. Mathematical disposition is one of the factors supporting the success of students' mathematics learning, but the current conditions of mathematical disposition are still low because the learning done has not fully facilitated students' abilities. Disposition as a desire, awareness, dedication, and strong tendency in students to reflect flexible thinking in exploring mathematical ideas to solve problems and act to behave positively, consciously and regularly with faith, piety and noble character as the basis [10-11].

2. Methods
This research is a quasi-experimental study conducted on class IX students of one junior high school in Bandung Regency. Based on the data gain and posttest data it was stated that there were differences in the significant increase in mathematical spatial ability both in the PAM category (initial knowledge of mathematics) and overall experience differences with the high average.

3. Results and discussion
Most students still have difficulty in solving the problem of spatial ability mathematically mentioning the elements of a cone build. Students have not written down what was asked, known and answered techniques. There are also some students who do not understand the purpose of the questions given, namely to mention the elements of a cone in the first picture of a cone, so that students first draw a cone build. The way the students work is still incomplete. Students should write down the cone elements in full by recording the points and lines in the picture. This shows that students have not met the indicators of spatial ability, namely stating the position between elements of a spatial construct and imagining the shape or position of a geometric object.
Figure 1. Learning activities with the Wingeom application.

Figure 1 shows the implementation of learning with the Wingeom application. Students learn together with their friends with the help of the application, there appears to be an interaction between friends. At the first meeting the workout of the learning problem has not been implemented maximally because more time is used for the explanation of the Wingeom application. But at the next meeting the process of doing the exercises went well. Each individual start working on the questions given to then be able to present the results of the answers. At each meeting students work on a problem exercise that contains indicators of mathematical spatial ability.

Based on the values obtained from the PAM test results data carried out both in the class using Wingeom applications and conventional classes, the minimum values, maximum values, mean or average and standard deviation were obtained. The data in more detail can be seen in table 1.

Table 1. Value of students' early mathematical knowledge (PAM).

| Class             | Ideal Value | Minimum | Maximum | Mean   | Standard Deviation |
|-------------------|-------------|---------|---------|--------|--------------------|
| Wingeom Application | 100         | 28      | 100     | 72.733 | 1.114              |
| Conventional      | 100         | 16      | 100     | 64.467 | 1.171              |

Table 1. shows that the average value of the initial mathematics class knowledge using different Wingeom applications and conventional classes. The average initial knowledge of mathematics in the experimental class using the Wingeom application is 72.733 with a standard deviation of 1.114 while the average initial knowledge of mathematics in the conventional class is 64.664 with a standard deviation of 1.171. Based on these data it can be seen that the initial knowledge of mathematics in the class that uses the Wingeom application is better than the conventional class. To find out the increase in students' mathematical spatial abilities, the data taken from the pretest and posttest was then searched for normalized N-Gain. Pretest is carried out before the use of Wingeom and posttest applications is carried out after the use of the Wingeom application. To see the N-gain statistical data can be seen in Table 2.
Table 2. Increased mathematical spatial ability.

| N  | Minimum | Maximum | Mean      | Std.Deviation | N-Gain Criteria |
|----|---------|---------|-----------|---------------|-----------------|
| Wingeom Application | 30 | 0.25 | 0.974 | 0.778012 | 0.176586 | High |
| Conventional       | 30 | 0.176 | 0.847 | 0.624215 | 0.149485 | Medium |

Table 2. shows that the average N-Gain ability test in the experimental class is better than students in the control class. The results of the two-way ANOVA test with the help of IBM SPSS Statistics 20 can be seen in Table 3.

Table 3. Anova test two paths of gain data based on PAM.

| Source                  | Type                   | III Sum of Squares | df | Mean Square | F     | Sig. |
|-------------------------|------------------------|--------------------|----|-------------|-------|------|
| Corrected Model         | .622a                  | 5                  | .124 | 5.233       | .001  |
| Intercept               | 15.849                 | 1                  | 15.849 | 666.229    | .000  |
| Model                   | .281                   | 1                  | .281 | 11.819      | .001  |

| Source                  | Type                   | III Sum of Squares | df | Mean Square | F     | Sig. |
|-------------------------|------------------------|--------------------|----|-------------|-------|------|
| PAM                     | .237                   | 2                  | .119 | 4.983       | .010  |
| Model * PAM             | .027                   | 2                  | .014 | .570        | .569  |
| Error                   | 1.285                  | 54                 | .024 |             |       |
| Total                   | 31.401                 | 60                 |    |             |       |
| Corrected Total         | 1.907                  | 59                 |    |             |       |

a. R Squared = .326 (Adjusted R Squared = .264)

Based on the results of data processing presented in table 3. PAM students have a Sig. The corrected model is 0.001 <0.05, then $H_0$ is rejected. This means that there are significant differences in students' mathematical spatial abilities based on the learning model and the level of PAM (high, medium, low) students simultaneously. The model has a sig value. 0.001 <0.05, then $H_0$ is rejected. This means that there are significant differences regarding the increase in students' mathematical spatial abilities in the learning model using Wingeom and conventional applications. Differences in mathematical spatial abilities of students in the class using the Wingeom application are better than students in conventional classes. This is because students in the class using the Wingeom application are required to be actively involved and learn independently with the application of the Wingeom application.

Based on the indicators of the average student attitude score, the average score of the highest attitudes of students lies in the indicators of self-confidence and persistence in facing and resolving problems, then indicators of the ability to share opinions with others and then indicators of high curiosity. The average percentage of students' attitudes towards geometry learning using the Wingeom application can be seen in Figure 1.
Based on Figure 2 above it can be seen that 71% of students generally respond positively and only 29% of students respond negatively. This shows that students are relatively happy and interested in following the geometry learning process using the Wingeom application. This is because the application of Wingeom applications is a new thing for students.

4. Conclusion
The ability improvement in the class through the Wingeom application of the high PAM category is better than the low category and better than the class that uses the conventional learning model with the high, medium and low PAM categories. The ability of the class through the Wingeom application in the PAM category is better than the high and low categories and better than the class that uses conventional learning models with high, medium and low PAM categories. The ability of the class through the Wingeom application in the low PAM category is no better than the high and medium category and is better than the class that uses conventional learning models with high, medium and low PAM categories. Based on the results of the student's disposition analysis questionnaire on geometry learning through the Wingeom application, the students' positive responses were shown. So, students can be interested in learning mathematics according to their needs.

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