Spatial thinking ability and mathematical character students through Cabri 3D with a scientific approach

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Abstract. The purpose of this study was to determine the differences in the increase in students' spatial thinking abilities; differences in achievement of spatial thinking skills based on students' Early Mathematics (PAM) knowledge; and the difference in increasing the mathematical character of students between before and after mathematics learning using the Cabri 3D software with a scientific approach. This study uses quasi-experiment, the experimental class uses Cabri 3D software with a scientific approach and the control class uses conventional learning. The results showed that: there were differences in the increase in spatial thinking skills; there are differences in achievement of spatial thinking skills based on PAM and there is interaction between PAM categories of students with learning in achieving students' spatial thinking skills; there is a difference in the improvement of students' mathematical characters between before and after mathematics learning using the Cabri 3D software with a scientific approach. Mathematics learning using Cabri 3D software with a scientific approach is one alternative to improve spatial thinking skills and mathematical character of students.

1. Introduction

Spatial abilities are very much needed in engineering and mathematics, especially geometry [1]. Spatial reliability is needed in everyday life and also spatial ability is very important for mathematics learning, one of which is in the field of geometry because it will make it easier for students to learn and understand geometrical abstracts, and when having good spatial abilities will make students have the ability to identify relationships and change geometry shape, geometry and spatial reasoning are inherently important [2]. According to students geometry is one of the subjects of mathematics which is classified as difficult to understand, the difficulties of students in primary and secondary education are closely related to spatial abilities [3,4]. Lack of imagination to visualize the components of the shape of the space so that students feel difficult in constructing geometric spaces and solving problems [5]. Development of spatial capabilities is a very important task for teachers to understand and develop students' geometric knowledge in a unified theoretical knowledge and spatial abilities that can be developed at the right age with appropriate teaching strategies [6].

Difficulties in understanding three-dimensional space or geometry are related to the difficulty of spatial thinking. Therefore, it is necessary to have the right geometry learning media that can help students visualize images. Computer technology has been experiencing a quite rapid development in
which it, in turn, has also caused a change in human life style [7]. One medium that is suitable for increasing spatial ability and can connect geometry and algebra that can measure length, distance, area, angle, and volume has the potential to be a useful tool for learning and spatial teaching in analytic geometry is Cabri 3D software [8,9]. In addition to the right media, the right approach is needed so that the learning process leads to children who can explore on their own, or learning that leads to inductive learning. One approach is the scientific approach. Learning using the scientific approach means that learning is done scientifically [10]. The stages of learning are as follows: (1) Observing, (2) asking questions, (3) gathering information, (4) associating, and (5) informing. So that this research uses 3D cabri software with a scientific approach.

2. Method
The research design used in this study was a quasi-experimental type. In this study, the experimental group, namely the group using 3D cabri software with a scientific approach and the comparison group used the control group, the group using conventional learning. The type of data used is quantitative data. Quantitative data were obtained from students' PAM data, the results of the pretest and posttest, and students' mathematical character questionnaires. Samples were selected randomly with purposive sampling. Object of research at one of the junior high schools in Bandung regency and the sample to be chosen by the researcher is two classes, namely class VIII B as the experimental class and class VIII C as the control class. The data used in this study were obtained through filling out the attitude scale questionnaire and tests. Data processing techniques are carried out quantitatively. Quantitative analysis was carried out on all data processing, both at the stage of processing PAM data, pretest and posttest to determine the increase and achievement of students' spatial thinking skills by using Cabri 3D software with a scientific approach, as well as improving students' mathematical characters.

3. Results and discussion
Based on the processing of data on the posttest value of students' spatial thinking skills both in the Cabri 3D software class with the scientific approach and in the conventional class, the minimum values, maximum values, mean or mean, and standard deviations showed posttest average spatial thinking ability students of the Cabri 3D software class with a conventional scientific and class approach are different. Following with the help of SPSS version 20 the posttest average can be seen in Table 1.

| Class                | N  | Min | Max | Mean   | Std. Dev |
|----------------------|----|-----|-----|--------|----------|
| Cabri 3D Software    | 25 | 50  | 90  | 71,040 | 11,505   |
| Convensional         | 25 | 14  | 89  | 50,040 | 18,698   |
| Total                | 50 | 14  | 90  | 60,540 | 18,670   |

In Table 1, it can be seen that the average posttest score in the Cabri 3D software class with the scientific approach is 71.040 with a standard deviation of 11.505. While the average posttest score in the conventional class is 50.040 with a standard deviation of 18.688. This shows that the posttest score in the 3D cabri software class with the scientific approach is better than the conventional class. For the categorization of students based on the initial knowledge of mathematics (high, medium, low) in the class that uses Cabri 3D software with a scientific approach and conventional classes can be done based on the criteria as in Table 2.

| Class              | Mean  | SD     | Mean + 1 SD | Mean – 1 SD |
|--------------------|-------|--------|-------------|-------------|
| Software Cabri 3D  | 76,560| 11,797 | 88,357      | 64,763      |
| Convensional       | 69,600| 19,276 | 88,876      | 50,324      |
Based on the criteria in table 2 both in the class using the Cabri 3D software with the scientific approach and the conventional class are divided into three groups of students based on the PAM value. The achievement of spatial thinking skills in the Cabri 3D software class with a scientific approach is better than the achievement of spatial thinking skills in the conventional class based on student posttest scores. To find out statistically the difference in achievement of spatial thinking skills between students using the Cabri 3D software and the scientific approach with students using conventional learning models based on the level of PAM (high, medium, low) students can be tested by two-way ANOVA. The results of the two-way ANOVA test with the help of SPSS version 20 can be seen in Table 3 below.

Table 3. Anova test two posttest data lines based on PAM.

| Source             | Type III Sum of Squares | F      | Sig. |
|--------------------|-------------------------|--------|------|
| Corrected Model    | 10016,721a              | 12,479 | .000 |
| Intercept          | 126453,925              | 787,685| .000 |
| Pam                | 3541,997                | 11,032 | .000 |
| Pembelajaran       | 6858,617                | 42,723 | .000 |
| Pembelajaran*PAM   | 1760,338                | 5,483  | .007 |
| Error              | 7063,699                |        |      |
| Total              | 200335,000              |        |      |
| Corrected Total    | 17080,420               |        |      |

Based on the results of data processing presented in Table 3, PAM students have a Sig. namely 0.00 <0.05, then H_0 is rejected. This means that there are significant differences regarding the achievement of students' spatial thinking skills based on the level of PAM (high, medium, low) students. It can be concluded that the factors of students' initial mathematical knowledge have a significant influence on the achievement of students' spatial thinking skills. To find out the difference in achievement of students' spatial thinking abilities between high, medium and low, a post-Hoc Tukey test was carried out. The results of the calculations using SPSS 20 are presented in Table 4.

Table 4. Post hoc tukey N-gain data test based on PAM.

| (I) Pam | (J) Pam | Mean Difference(I-J) | Sig. |
|---------|---------|----------------------|------|
| High    | Medium  | 13,87019a            | 0.040|
| Low     | Medium  | 20,68750a            | 0.023|
| Medium  | Low     | -13,87019a           | 0.040|
| Low     | Low     | 6,81731              | 0.599|
| Low     | Medium  | -20,68750a           | 0.023|
| Medium  | Medium  | -6,81731             | 0.599|

* The mean difference is significant at the 0.050 level.

Learning in the experimental class that uses Cabri 3D software with a scientific approach with the control class that uses conventional learning models there are differences because in Table 4 it can be seen that for the Sig. 0.00 <0.05, then H0 is rejected. That is, there are differences in the achievement of significant spatial thinking skills of students between students who use the Cabri 3D software with a scientific approach with classes that use conventional learning models that are reviewed from the whole. The difference in achievement of students' spatial thinking skills based on the level of PAM (high, medium, low) class students who use Cabri 3D software with a scientific approach is better than the class that uses conventional learning models. Cabri 3D software supported activities contributed to development student mathematics teachers' spatial skills [11].

The difference in increasing the mathematical character of students between before and after learning using the Cabri 3D software with a scientific approach is known by analyzing the pretest and posttest data from the given questionnaire then processed using the paired t test formula.
Table 5. Gain paired data t test.

| t   | dF | Sig. (2-tailed) |
|-----|----|-----------------|
| -4.273 | 24 | .000            |

Table 5 shows that the sig. (2-tailed) value is 0,000 <0,050 so that H0 is rejected, meaning that it can be concluded that the improvement of students' mathematical character after learning by using Cabri 3D Software with a scientific approach is better than before learning by using Cabri 3D software with a scientific approach. The results indicated that students using the software Cabri 3D were significantly more successful in terms of identifying the equations of the special planes [12].

4. Conclusion

Based on the results of research on mathematics learning using Cabri 3D software with a scientific approach there are differences in the achievement of students' spatial thinking abilities using the Cabri 3D software with a scientific approach with those using conventional learning based on PAM levels (high, medium, and low) students. From the posttest mean, it can be seen that the class that uses 3D cabri software with a scientific approach to the level of PAM (high, medium and low) is better than the conventional class with the level of PAM (high, medium and low). There is a difference in the improvement of students' mathematical characters between before learning using the Cabri 3D software with a scientific approach and after learning that uses the Cabri 3D software with a scientific approach. This means learning mathematics using the Cabri 3D software with a scientific approach can improve, achievement of spatial thinking skills and mathematical characters of students.

References

[1] A Z Kovács and L Németh 2014 Development of spatial ability according to mental rotation test at SKF and YBL. Ybl J Built Environ. 2(1) 18–29.
[2] D H Clements 2004 Geometric and spatial thinking in early childhood education. Engag Young Child Math Stand Early Child Math Educ. 267–97.
[3] S Zulayfa 2017 Penerapan Pembelajaran Savi Berbantuan Software Google Sketchup untuk Meningkatkan Keterampilan Dasar Geometri Siswa: Studi Kuasi Eksperimen Di Salah Satu SMP di Kabupaten Deli Serdang.
[4] E Febriana 2015 Profil kemampuan spasial siswa menengah pertama (smp) dalam menyelesaikan masalah geometri dimensi tiga ditinjau dari kemampuan matematika. J Elem. 1(1) 13–23.
[5] R D Siswanto and Y S Kusumah 2017 Peningkatan Kemampuan Geometri Spasial Siswa SMP melalui Pembelajaran Inkuiri Terbimbing Berbantuan Geogebr. J Penelit Dan Pembelajaran Mat. 10(1).
[6] R Nagy-Kondor 2007 Spatial ability of engineering students. 113–22.
[7] L T Muharlisiani. Implementing Mobile Computing Exercises Based On Android In Creating Ideas To Facilitate Independence Learning Of Reading Comprehension.
[8] R Rososzczuk 2015 Application of Cabri 3D in teaching stereometry. Adv Sci Technol Res J. 9(26) 148–51.
[9] T Kösa and F Karakuş 2010 Using dynamic geometry software Cabri 3D for teaching analytic geometry. Procedia-Soc Behav Sci. 2(2) 1385–9.
[10] M Muhammad and N Nurdyansyah 2015 Pendekatan Pembelajaran Saintifik.
[11] B Güven and T Kosa 2008 The effect of dynamic geometry software on student mathematics teachers’ spatial visualization skills. Turk Online J Educ Technol-TOJET. 7(4) 100–7.
[12] E Ertekin 2014 Is Cabri 3D Effective for the Teaching of Special Planes in Analytic Geometry? Int J Educ Stud Math. 1(1) 27–36.