PROCEEDING ISBN : 978 – 979 – 16353 – 7 – 0

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Traditional Teaching About Angles Compared To An Active Learning Approach That Focuses On Students Skills In Seeing, Measuring And Reasoning, Including The Use Of Dynamic Geometry Software: Differences In Achievement

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Abstract

This research was about an intervention developed for students at the junior high school level, in which the researcher was teaching the concept of angles through paper exercises as well as dynamic geometry software (DGS), using an active learning approach. This research was to find out the impacts of the use of such an approach on students in their learning activities. The researcher compared two parallel classes at the same level, which were the first level of junior high school (age 13-14 years old). The experimental class was taught by the researcher according to the designed intervention. Meanwhile, the control class was taught by the collaborative teacher according to her regular teaching method without using DGS. The data were collected by means of tests (pretest and the posttest), questionnaires, and interviews. Analysis of the pretest scores shows that the experimental class did better than the control class did, but there was initially no significant difference. After the intervention, analysis shows that the experimental class did better than the control class in the end, and the difference was significant.

Key words: Active learning, DGS, Student's achievement, Traditional teaching.

I. INTRODUCTION

1. Background

In my opinion, teaching mathematics is a very challenging thing to do because mathematics teachers, students, and mathematics subjects should be running together in harmony, which means mathematics teachers teach using an appropriate teaching method for students, students are able to engage in their learning activities, and the mathematics subjects taught are appropriate and suitable to students' level of thinking. One of possible problems in teaching and learning mathematics is that mathematics teachers, in their opinion, think that their regular teaching method is appropriate to students without trying to evaluate whether students are really satisfied with their teaching method. On the other hand, students do not think that their mathematics teachers use an appropriate teaching method for teaching them. Meanwhile mathematics is still considered as a difficult subject to learn by some students. Actually there are some reasons for this condition, such as students do not see the relevance of mathematics to their life, which makes it hard for them to understand it; mathematics

teachers do not provide suitable and appropriate teaching methods so that students are not engaging in learning mathematics; there is no available teaching-learning media to help students become more enthusiastic and motivated to learn mathematics.

I think that to overcome this condition, mathematics teachers should be more innovative in their teaching methods. Mathematics teachers also should consider the use of ICT in their teaching. There exists a lot of research investigating the use of ICT in education, and it shows that students become more independent in doing their learning activities when they engage in learning through ICT tools. An example of the use of ICT in education is the use of mathematics software to teach students. There are many kinds of mathematics software, such as Cinderela, Geogebra, Mathematica, etc. Mathematics software nowadays is easy enough to use, most are really user friendly, so that users do not need special computer skills to use them.

Dynamic geometry software is a computer program by which a user can construct or create any plane geometrical shape, and can manipulate it as well. Therefore dynamic geometry software is really helpful for teaching and learning geometry, because in it there are a lot of tools that can be used to visualize and to construct geometrical shapes in simple ways. By learning geometry through dynamic geometry software, the researcher hopes that students will be more excited about learning geometry, and it will make them engage more in their learning activities.

I do not mean to imply that a traditional way of teaching geometry is not appropriate to students. However, to use those tools, such as a protractor, a ruler, and a compass, is sometimes difficult for students and it takes time to create or construct geometrical shapes. Therefore some students will lose the time needed to understand geometry, because the drawing of geometrical figures is so time consuming, and this condition makes students think that learning geometry is not fun and it is difficult as well. It shows that students' achievement and opinion are affected by the tools used for teaching. This condition triggered me to do a research study in which I conducted an intervention of teaching geometry through dynamic geometry software. I wanted to compare students' achievement in learning geometry in a class taught in the traditional way and a class taught according to the designed intervention.

2. The main research question:

Is there any difference in students' achievement between those who have been taught about angles according to an active learning approach using DGS and those who have been taught in the traditional way, both in a first level of junior high school in Indonesia?

3. Sub-research questions:

There were three sub-research questions to be investigated.

1. Does the active learning approach using DGS help motivate students to learn geometry?
2. Do students feel that the active learning approach using DGS helps them to understand geometry?
3. Does the active learning approach using DGS help students to improve their abilities of seeing, measuring, and reasoning in learning geometry?

4. Expectation of the research

In this research, the researcher expected that the researcher's intervention would make a significant difference in students' achievement between those two classes.

The researcher also expected that the researcher's intervention would help motivate students to learn geometry. The researcher expected that the intervention would help students to understand geometry, and that students would notice this. Because the intervention assignments, both the paper and DGS assignments, were aimed at improving students' abilities in seeing, measuring and reasoning, the researcher expected to see improvements in students' ability to recognize angles and angle patterns, to measure angles, and to reason about angles.

II. RESEARCH METHOD

2.1 Research design

There were two classes involved in this research, which were the experimental class and the control class. Both classes were at the same level of junior high school, which was the first level. However in this research, the experimental class and the control class got different treatments. The control class was taught by the researcher using the set of activities which were developed by the researcher. Meanwhile the

control class was taught by the collaborative teacher using her own regular teaching method.

The researcher developed a set of activities in which students of the experimental class could learn a geometry topic about angles, doing this in a double section for each meeting. During the first section students did activities without using dynamic geometry software, and during the second section they learned geometry using dynamic geometry software. In this research the researcher used Geogebra software. Meanwhile, the collaborative teacher developed her own lesson activities with her own choice of mathematics books and dynamic geometry software was not involved in these activities.

2.2 Data collection methods

To answer the main research question and the sub-research questions, the researcher used a pretest, a posttest, questionnaires, interviews, and research field notes as data sources.

Pretest and Posttest

Before the experimental teaching of the angle concept starts, both classes did a pretest; after the teaching of angles ended, both classes did a posttest. The pretest and the posttest were not exactly the same, but they were about the same topic which was geometry of angles to the extent that it was taught during the intervention.

In order to answer the main research question, *"Is there any difference in students' achievement between those who have been taught about angles according to an active learning approach using DGS and those who have been taught in the traditional way?"*, the researcher compared the results of the pretest and the posttest between the experimental class and the control class.

Questionnaires and Interview

In order to answer to the sub research questions, *"Does the active learning approach using DGS help motivate students to learn geometry?"* and to answer the sub research question, *"Do students feel that the active learning approach using DGS helps them to understand geometry?"*, the researcher used the results of the questionnaires and interviews. The interviews involved the collaborative teacher and three students of

the experimental class (individually), and the questionnaire involved all students of the experimental class.

Findings during the intervention

In order to answer the sub research question, *"Does the active learning approach using DGS help students to improve their abilities of seeing, measuring, and reasoning in learning geometry?"*, the researcher will use the findings during the intervention: journal notes, video recording of lessons, and students' answers to pen-and-paper assignments.

To get all the data needed to answer the research questions, the researcher: (1) gave the pretest to the two classes, (2) gave an introduction of Geogebra to the experimental class, (3) taught the intervention to the experimental class, (4) collected students' answers to pen-and-paper assignments from the experimental class, (5) wrote a journal of the taught lessons, (6) recorded the lessons on video, (7) gave the posttest to the two classes, (8) gave the questionnaires to the experimental class, (9) interviewed the collaborative teacher and three students of the experimental class, separately.

2.3 Data analysis method

- Pretest and posttest were compared using t-test and ANCOVA.
- Questionnaire results were elaborated by devising categories for the one open question. For the closed (Likert scale) questions, for each question the students' answers were classified as positive, negative, or neutral with respect to the intervention.

Findings during the intervention were analyzed by comparing students' answers to expected answers and in case of big differences: trying to understand the reasoning behind students' answers. Difficulties that appeared more than once were noted and for each of these difficulties it was attempted to determine if students did overcome the difficulty and if so, how.

III. RESULT AND DISCUSSION

In this section, I will tell about the result of my research based on data analysis and findings.

The main research question: *Is there any difference in students' achievement between those who have been taught about angles according to an active learning approach using DGS and those who have been taught in the traditional way?*

The analysis of the pretests shows that the experimental class got a higher score-mean (67.58) than the control class (64.69). To know whether they were really similar or not, the independent-samples t-test is used to investigate it. The outcome gives information that the Levene's test for equality of variances shows that the value F (1.461) is not significant (0.237) which means that there is no significant different in the variances of the two classes, therefore in this case we may assume equal variances. Under this assumption the t-test gives a significance value (2-tailed) of 0.474 which is more than 0.05, therefore there is no significant difference between the means of the two classes. It means that before the intervention to the experimental class, the two classes had the same level of knowledge in geometry.

In the posttest results the experimental class reached the score-mean 64.49, meanwhile the control class got a score-mean 49.49 out of the maximum score (150). It shows that the experimental class did better than the control class did, with a difference of 15.00 between the means. The outcome of the independent-samples t-test shows that under the Levene's test for equality of variances the value F (0.413) is not significant (0.522), which means that there is no significant difference between the variances of the two classes. Therefore we may assume equal variance. Using that assumption, the t-test for equality of means shows a significance (2-tailed) of 0.004 which is less than 0.05, therefore there is a significant difference between the means of the two classes. It is a lot more significant than the researcher hoped for.

By all those findings I can say that the experimental class reached a better achievement than the control class did after the intervention, and that there is a significant difference between those classes' achievement.

The first sub-research question: *Does the active learning approach using DGS help motivate students to learn geometry?*

According to the questionnaire results (multiple choice question), 94.3% of students answered that they were motivated by learning geometry through Geogebra, which shows that almost all students were motivated by the intervention. From the

findings of the collaborative teacher's interview, students were motivated by the intervention in which they got their first experience of learning mathematics through computers, especially learning geometry through Geogebra. From all those findings I conclude that the active learning approach using DGS helps motivate students to learn geometry.

The second sub-research question: *Do students feel that the active learning approach using DGS helps them to understand geometry?*

Based on the findings of the questionnaire question 1, which was an open question, 80% of students said that learning through Geogebra helped them to understand geometry. Meanwhile based on the findings of the questionnaire question 3, which was a closed statement, 97.1% of students agreed that learning through Geogebra helped them to understand geometry. The findings of the three student interviews give information that learning through Geogebra helped them to understand geometry. By all those findings, I conclude that students think that the active learning approach using DGS helps them to understand geometry

The third sub-research question: *Does the active learning approach using DGS help students to improve their abilities of seeing, measuring, and reasoning in learning geometry?*

Based on the findings of all meetings, I could say that students gradually improved their abilities of seeing, measuring, and reasoning in learning geometry, even though students sometimes still made some mistakes in doing the tasks of each meeting. For example, for question 1e, I found that all students did not yet know how to give a reason in mathematics. At this stage, I just encouraged students to give their own reasons and arguments, no matter if it was wrong or not, because I hoped students would become more confident in their own thinking in learning mathematics. And it worked, because after that, I saw that students were more confident and brave to propose their own thinking. For question 1f, I found that some students (four groups) showed improvement in giving correct reasons to a specific situation. They also had been triggered to explore their intuition skill during the intervention. In the first meeting, for question 7, students did not recognize what they just constructed was a block, probably, because the picture was still not clear as a block. This evidence shows that students did not succeed using their intuition skill at this question. However, since then students were triggered to use their intuition skill in learning geometry, and some students did well on this. For instance, in the third meeting, for question 3a, some students used their intuition skill well and gave a good reason in their answers. And they came to more understanding on how to measure an angle by using a protractor and by using Geogebra. For example, in the fourth meeting, I found that students had a problem

in using a protractor to answer question 1b. To overcome this problem, I gave an explanation on how to use a protractor properly, and students showed improvement, which was on question 3, I found that students did not have a problem in using a protractor to answer the question, and they could classify angles into categories without any mistakes. Of course, there were many mistakes, that students made during learning activities. This could be because they had difficulty to maintain what they had just learned. However, overall I conclude that students showed gradual improvement in their abilities of seeing, measuring, and reasoning in learning mathematics, especially in learning the concept of angle in geometry.

Motivation is one of the important things which a student should have in learning mathematics. However, to trigger and to maintain students' motivation in learning mathematics is challenging for mathematics teachers, because most students, everywhere, consider mathematics a boring and difficult subject. An interesting case which I found in my research based on the collaborative teacher interview is: there is a student of the experimental class, Sindi, showing a significant change in her behavior in learning mathematics after my intervention was done. The collaborative teacher said that before my intervention, Sindi did not show her talent and ability in mathematics so much, but now she has become one of the active and diligent students in learning mathematics. From this finding, I can say that my intervention triggered Sindi's motivation to learn mathematics. Even though to trigger students' motivation is not easy, but to maintain students' motivation is much harder. The collaborative teacher said that she was a bit afraid that she could not maintain her students' motivation after my intervention, because she could not apply my kind of intervention to all her classes. Actually, she wanted to apply it, but she could not teach only one or two classes in this way while the other parallel classes get the traditional way.

This study has shown that the active learning approach using DGS is helpful for teacher and students. However, this research actually had some limitations, which were: (1.) the intervention was only conducted within a short period of time (5 meetings within 5 days, each meeting 2x45 minutes); (2.) The computers used in this researcher were very limited (only 6 computers for 36 students); (3.) The participants were junior high school students and they did not yet have any experience learning mathematics through computers (it was really exciting for them); (4.) the experimental class was quite big (36 students), which made class management a bit difficult.

As we know, nowadays teaching and learning through DGS is known among mathematics teachers, and also there has been a lot of research which was conducted to investigate about learning geometry through DGS. One of them is the research conducted by Sang Sook Choi-Koh (a professor of mathematics education from Korea), who investigated the geometric learning of a secondary school student during

instruction, on the basis of the van Hiele model, with dynamic geometry software as a tool (Choi-Koh, 1999). In his research, he examined the changes in the students' learning according to the van Hiele levels of geometric thought for the geometric topics of right triangles, isosceles triangles, and equilateral triangles. The participant of his research was a student called Fred. However, this student had not taken geometry but had taken a computer course or had had experience with a computer at home, which means that he did not yet have experience in learning geometry, but had computer skills. In his research, he investigated Fred through four learning stages, which were: 1. Intuitive learning stage, 2. Analytical learning stage, 3. Inductive learning stage, and 4. Deductive learning stage. During his investigation, he saw that Fred was really enthusiastic doing the given task, and he also found that Fred properly performed the task, and also Fred did the task in a much simpler way than he expected. He also found that the visualization by dynamic computer software helped Fred make some conjectures about relationships between triangles. Even though the background of the participant was different from my participants' background, the results of his research about using dynamic geometry software shows also that learning through the intervention in which DGS is embedded helps motivate students to learn with more enthusiasm, which could lead students reaching better achievements in their study.

IV. CONCLUSION AND SUGGESTION

All the limitations in my research resulted in a struggle to reach a better teaching situation. Therefore the results of this study cannot be generalized to other situations. However, the result of this research can be used as a reference for mathematics teachers who want to try the active learning approach through DGS in their teaching. Therefore, for future research on active learning approaches using DGS, I suggest to investigate it for a longer series of lessons and with sufficient computers for the students. This kind of research could be useful to apply also at a senior high school level, where making mathematics more interesting to students might result in more students pursuing a career in mathematics, and also the geometry topics that students learn are more advanced.

Finally, I want to say that in learning mathematics, motivation is like a spirit of life, which means that learning activities become lively when students have good motivation. Therefore mathematics teachers should be innovative and creative in their teaching method, not only to trigger students' motivation, but also to maintain students' motivation.

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