Guided discovery learning in geometry learning

V N Khasanah¹,*, B Usodo¹ and S Subanti¹

¹Departement of Mathematics Education, Sebelas Maret University of Surakarta, Jl. Ir. Sutami 36A Kentingan Jebres Surakarta, Indonesia

*Corresponding author: vertyenoorkhasanah@gmail.com

Abstract. Geometry is a part of the mathematics that must be learned in school. The purpose of this research was to determine the effect of Guided Discovery Learning (GDL) toward geometry learning achievement. This research had conducted at junior high school in Sukoharjo on academic years 2016/2017. Data collection was done based on student’s work test and documentation. Hypothesis testing used two ways analysis of variance (ANOVA) with unequal cells. The results of this research that GDL gave positive effect towards mathematics learning achievement. GDL gave better mathematics learning achievement than direct learning. There was no difference of mathematics learning achievement between male and female. There was no an interaction between sex differences and learning models toward student’s mathematics learning achievement. GDL can be used to improve students’ mathematics learning achievement in geometry.

1. Introduction

Geometry is part of mathematics that must be learned in school [1]. Geometry contributes to develop students’ spatial awareness, good reasoning, visualizations, analysis the problems and solve natural problems like everyday life problems [2]. A geometrical figure is an abstract, ideal entity, a general representation of a category of objects [3]. Many students find difficulty in geometry due to their minds are accustomed to think concrete objects. Students more often use visualizations rather than verbal definitions in classifying and identifying shapes on geometry. This causes students get misconceptions about geometry. Learning geometry may not be easy, and a large number of the students fail to develop an adequate understanding of geometry concepts, geometry reasoning and geometry problem solving skills [4]. Some factors are identified to make the learning of geometry concepts difficult which include: teachers’ methods of instruction, geometric language, visualizing abilities [5].

Based on the observation and results of interview with teachers, it can be seen that teachers were still using direct learning in giving the lesson of geometry, the active learning was not seen, and students got the formula of geometry directly from the teachers. One-way learning comes from teachers where students were not directly involved in building their understanding. Direct learning focused on procedures followed by teachers and the curriculum and identify specifically and explicitly what skills need to be learned step-by-step, instead of leaving students to their own experience [6]. Students tend to memorize formulas without understanding the concepts in geometry. Many young children have numerous misconceptions about geometry when a teacher discusses a geometry proof problem in class, it generally involves oral presentation of a formal proof and body movements.
pointing at different parts of the figure of the problem [7]. Therefore, teachers must design and implement various models of learning that appropriate to each subject provided. The learning process is expected to be student oriented with the principle of students seeking knowledge independently with the source not only from the teacher. One of the learning model involving students in constructing their knowledge is guided discovery learning model (GDL).

Discovery learning model is a learning model that trains students to solve problems. Discovery learning is student-centered learning where students are given the freedom to try, use intuition, investigate, and obtain information through group discussions to find solutions based on their own activities and observations [8]. Human learn better and deeper when they are required to discover and construct essential information for themselves [9]. However, in pure discovery learning takes a relatively long time, minimal feedback will get error and frustrated situations [9]. The role of teachers is very important in providing motivation, guidance, and direction in discovery activities. Teacher's guidance is not a kind of rule that must be followed instead of the required work procedure direction. GDL is a learning model that requires students to be actively involved in learning by discovering and investigating their own knowledge that will be obtained through teacher guidance. The results of the research [10] GDL is more effective than conventional model to improve students’ understanding toward integral. Other than, [11] concluded the use of GDL is more effective than pure discovery in helping students to learn.

In the process of learning activities many students are involved both male and female where each student has the same opportunity to obtain information about the material from the teacher. Sex differences are the differences between male and female referring to anatomy and biologically. One of the differences between male and female is the brain. There are differences structure of male and female brain which is caused the differences of spatial and verbal ability. Male students perform better in spatial cognition, computational fluency, and attitudes toward mathematic, while female perform better than male in verbal memory [12]. According [13] differences between male and female in problem solving that male tend to be good in abstraction, mathematical reasoning and more accurate on the target, while female better understand concrete things, better in remembering and mathematical calculations. The results of the research Rabab’h that the score in mathematics achievement for female students was higher than the score for male students among eight grade school. However, it was inconsistent with the results of the research Santos that there were no significant differences in students’ (12-13 years old) mathematics achievement when differentiating them by sex (boys and girls). Based on the problems described above that the formulation of the problem whether there is the learning model gave a different effect on mathematics learning achievement, whether there is different of sex differences in mathematics learning achievement, and whether there is an interaction effect between sex differences and learning models.

2. Methods
This research used a quasi-experimental research with factorial design $2 \times 2$. The aim of this research was to know the influence of two independent variables to dependent variable. The independent variables in this research were models learning which GDL as an experimental class and direct learning as control class, and then sex different between male and female, while the dependent variable was student’s mathematics learning achievement. The population in this research was a seventh grade of SMPN 2 Mojolaban in the academic years of 2016/2017. The sample was taken by using cluster random sampling. The sample used is VII J which amounted to 34 students as an experimental class and VII H which amounted to 32 students as control class. This research used two methods of data collections, that were documentation method used to get student’s profile data and the test method used to obtain student’s mathematics learning achievement data that contains the indicators of geometry materials in the form of multiple choice questions. In this research prior to testing the hypothesis by two ways analysis of variance (two-way ANOVA) with unequal cells that the research data should qualify analysis includes a data distribution normality test, and homogeneity of variance test.
3. Result and Discussion

Prior to the two-way ANOVA test, normality and homogeneity were performed on the data with significance level 5% by using SPSS. The result of normality test of student’s mathematics learning achievement showed that from experimental class and control class the sig. value > 0.05 that were 0.064 > 0.05, and 0.092 > 0.05. This indicated that the sample of students’ mathematics achievement test came from a normally distributed population. The result of homogeneity test of student’s mathematics learning achievement between experiment class and control class showed the sig. value > 0.05 that was 0.143 > 0.05. This indicated that the population has the same or homogeneous variance. Hypothesis testing in this study using two-way ANOVA with unequal cells showed in Table 1 with following results.

Table 1. The Result of Two-Ways ANOVA with Unequal Cells

| Source        | Type III Sum of Squares | Df | Mean Square | F     | Sig. |
|---------------|-------------------------|----|-------------|-------|------|
| Corrected Model | 1370.783*               | 3  | 456.928     | 3.842 | .014 |
| Intercept     | 299191.059              | 1  | 299191.059  | 2515.946 | .000 |
| Model         | 1018.479                | 1  | 1018.479    | 8.565 | .005 |
| Sex           | 283.815                 | 1  | 283.815     | 2.387 | .127 |
| model * sex   | .729                    | 1  | .729        | .006  | .938 |
| Error         | 7372.910                | 62 | 118.918     |       |      |
| Total         | 312386.045              | 66 |             |       |      |
| Corrected Total | 8743.693              | 65 |             |       |      |

Based on the calculation in Table 1 showed the effect of learning model on mathematics learning has a value of F obtained of $F = 8.565$ with sig. value $0.005 < 0.05$ so, $H_0$ rejected and $H_a$ accepted. It can be concluded that there was difference effect using learning model in mathematics learning achievement. In experimental class had average score 71.532 and in control class had average score 63.645 so it concluded GDL greater than direct learning in student’s mathematics learning achievement. The effect of sex different on mathematics learning achievement has a value of $F$ obtained of $F= 2.387$ with sig. value $0.127 > 0.05$ so, $H_0$ accepted and $H_a$ rejected. It can be concluded that there was no difference between male and female in mathematics learning achievement. From Table 1 showed model * sex has a value of $F$ obtained of $F= 0.006$ with sig. value $0.938 > 0.05$. It can be concluded that there was no an interaction between learning models and sex different in mathematics learning achievement. There was no difference in achievement between male and female in direct learning or GDL. In GDL both male and female have a better learning achievement than the direct learning.

In direct learning teacher presented the material with a lecture and the students tend to listen and receive what the teacher said, then proceed with examples and questions. Students tend to be able to solve of geometry problems that teachers have modeled. But difficulty when the problem slightly changed from the example of teachers, it was because students only memorize the formula and did not understand the concept of geometry. Therefore teachers implement GDL in geometric learning which the principal content of what is to be learned is not given but must be discovered by the learners. GDL encourages students to actively identify problems, gather information to build their own knowledge through teacher guidance and direction. The essential of GDL that the teacher guided students to use their previous knowledge to find a concept of geometry. So, the formulas of geometry could be found by students without the teacher gave the formulas directly. GDL combines pointing the way to understanding or problem-solving by a guide with the discovery of facts, relationships, and solutions by students themselves, as they explore, manipulate objects, discuss, or perform experiments, drawing upon their own experience and existing knowledge [16]. Mayer recommend using GDL because it helps students meet two important criteria for effective learning. Firstly, activating or constructing
appropriate knowledge to be used in making sense of new incoming information. Secondly, integrating new incoming information with appropriate knowledge [11]. The results of the research [17] showed that by using GDL could increase student activeness in mathematics learning. Other than, the results of the research [18] showed that group guided discovery increased their mathematical performance from below average to above average in geometry.

In this research between male and female have the same positive attitude toward mathematics learning. A wide range of sociocultural forces contribute to sex differences in mathematics and science achievement and ability [19]. Moreover [19] human brain development is also altered by life experiences. There were no significant differences in students’ (12-13 years old) mathematics achievement when differentiating them by sex (boys and girls) [15]. There were no significant difference between male and female students in overall science achievement [20].

Prince and Felder said that GDL was an inductive learning model that was relevant with constructivism theory. Constructivism was a theory that suggests that learners construct knowledge out of their experiences which was associated with pedagogical approaches that promote learning by doing or active learning [22]. Teacher roles in constructivist teaching was to serve as facilitator of learning in which students were encouraged to be responsible and construct their own understanding. In GDL the teacher should guide the students by giving them questions to gain ideas in obtaining geometric concepts. The benefits of learning by using GDL was to have a positive impact on students such as critical thinking, creativity, problem solving and motivated in learning through to active. In GDL the student not only memories the formula or concept but also build their own concept understanding. Students understand the true subject matter because students experience the process of discovery. So, their learning process will lead them to intended understanding and will be able to transfer their knowledge to various contexts. So it created meaningful learning.

4. Conclusion

Based on the results and discussion it can be concluded GDL gave positive effect towards mathematics learning achievement. GDL gave better mathematics learning achievement than direct learning. There was no difference of mathematics learning achievement between male and female. There was no an interaction between sex differences and learning models toward student’s mathematics learning achievement. GDL could be an alternative of learning to improve students’ learning achievement in geometry higher than direct learning.

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