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The Effect of Learning Strategy and Cognitive Style toward Mathematical Problem Solving Learning Outcomes

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Abstract: *This study aims to analyze and determine the effect of learning strategies (The differences between Problem Based Learning and Direct Instruction) and cognitive style on mathematical problems solving learning outcomes. This study used a quasi-experimental research design (nonequivalent control group designs) The research subjects were students from state elementary school of V grade in Gading I Surabaya, east java. The totals of elementary school population in east Surabaya were 141 elementary schools. The selected schools are the schools which have some parallel classes, therefore the circumstances are relatively similar. Four classes are selected, they were from SDN Gading 1 state elementary school. These schools were randomly chosen to implement different learning strategies, they are implementing problem-based learning and hands-on learning. The data collection techniques were mathematical problems solving learning pre-tests and post-test, Group embedded figures test (GEFT) for cognitive style, assessment performance for learning achievement. Data analysis techniques in this study use ANOVA technique (analysis of variance) two lines. The results of this study showed that (1) there is a difference in learning achievement between the students' groups who are taught by PBL and direct learning; (2) there are differences in achieving learning outcomes toward students' group and different cognitive styles; (3) there are significant interactions between the use of learning strategies and cognitive style on learning outcomes.*

Keywords*: learning strategy, problem based learning, direct instruction, cognitive style, learning outcomes.*

I. Introduction

The learning process today at the primary level is still using the learning in one direction. The learning process which is used is lecturing method and giving the task, so it can decrease the students' creative thinking. It is not surprisingly, that is the reason of our children ability is low. Based on trends data in international mathematics and science study (TIMSS), mathematics in Indonesia ranked at the bottom level. The average score of mathematics achievement in Indonesia based on the TIMSS in 2011 position was rated 38 out of 45 countries. Comparing to the results of the TIMSS emerging quadrennial, there is an appearance in decreasing the 403 points in 1999, 411 points in 2003, 397 points in 2007, and fell to 386 points in 2011. It shows that our students have a basic knowledge of mathematics but it is not enough to be able to solve the problem. In 2005, Gallup Youth Survey conducted a poll to the students in the United States subject at school they consider mathematics as the most difficult subject. They say mathematics is still considered to be the hardest lesson 37% followed by 20% of science and the third position is 18% English language lessons. There are several factors happening, among others: (1) In conducting learning process teachers were dominant in their lesson, so that students become passive, (2) learning strategies that are used is monotonous, so it declines the students' interest in learning, (3) the contribution of students' learning styles in learning is still less significant.

The success in the learning process can not be separated from the role of a teacher, they are not only creates classroom atmosphere to be pleasant but also determines the appropriate learning strategies with heterogeneous classes. It can be ascertained that the selection of learning strategies greatly affect student learning outcomes. One learning model that can motivate students in learning is problem-based learning. Problem based learning (PBL) provides an opportunity for students to get more involved in the learning process, and stimulate students to think critically and problem-oriented. Cankoy & Darbas (2010) reported a preliminary understanding of a problem for students is very important in solving the problem. Mayer, 1992 in Malik and Iqbal, (2011) stated that solving the problem is a process where students can find the relationship between prior experience of the problems faced and then find a solution. Hung (2007) in his research concluded that the problem-based learning is effective in improving students' ability to apply knowledge in the real world, proficiency in solving problems independently, and independent learning skills. The same thing also delivered by Tosun and Taskesenligil (2012) that PBL had a positive contribution in motivating students. In learning in primary schools are still not oriented to the problems that occurred real life, this is caused by several things, among others (1) problem-based learning, including new things to be applied in schools, (2) curriculum 2013 that applied in schools including the new curriculum, the application still needs to be studied further, (3) not all teachers understand how to implement the problem-based learning (PBL), (4) The support facilities for PBL

learning do not supported anymore, (5) in the classroom teachers are still not accommodate the cognitive styles of students in learning.

Cognitive style as the characteristics, self-consistently mode was work by individuals which enable to demonstrate their perception and intellectual activities. Woolfolk (1993) also suggests that cognitive style is about how a person receives and organizes information from the surrounding world. Witkin and Goodenough in Danili & Reid (2006) defines the main characteristics of cognitive style Field Dependent-Field Independent as follows: Style cognitive Field Dependent (FD) are individuals who is lack or can not separate from any part of a whole and tend to immediately receive part or the dominant context. Cognitive style Field-Independent (FI) is the individual who can easily be 'free' from the perception of an organized and immediately be able to separate a part of its unity. According to Liu and Ginter (1999) the characteristics of the individual field independent in learning, namely: (1) focus on curriculum materials in detail, (2) focus on facts and principles, (3) rarely interact with the teacher, (4) formal interaction with the teacher just made to do chores, and tend to choose individual awards, (5) prefer to work alone, (6) prefers to compete, (7) able to organize information independently. While the characteristics of individual fields dependent in the study are: (1) accept the concept and matter in general, (2) a bit difficult to connect the concepts in the curriculum with his own experiences or prior knowledge they already have, (3) Like looking for guidance and user teachers, (4) requires a prize or award to strengthen the interaction with the teacher, (5) likes to cooperate with others and appreciate the opinions and feelings of others, (6) prefer to cooperate rather than working alone, (7) prefers organization material prepared by the teacher. Learning conditions that allow students who have the cognitive style field-independent learning optimally, according to Musser (1997), among others: (1) learning to provide a learning environment individually, (2) provided more opportunities to learn and find themselves in a concept or principle, (3) provided more resources and learning materials, (4) learning only a few provide the guidelines and objectives, (5) give priority to instruction and goals individually, (6) provided an opportunity to make a summary, a pattern, or a concept map based thoughts.

Students who have field-dependent cognitive styles tend to prefer to groups learning and frequently interacting with teachers, requiring reward / reinforcement that is extrinsic. For students with field-dependent cognitive style of these teachers need to design what to do and how to do it. They will work if there is a teacher guidance and motivation in the form of praise and encouragement. While learning conditions that allow students who have the cognitive style field dependent, in order to learn optimally among others: (1) learning group or learning in a social environment, (2) given more instructions clearly and explicitly, (3) provided certain strategy before performing an instruction, (4) served more feedback.

FD students who tend to be more oriented to people and social relationships than the FI for example, they tend to be better at remembering social information such as conversations and relationships, work well in a group, and to choose subjects such as history and literature. FI students are more likely to do well with numbers, science, and problem solving tasks (Wapner & Demick.1991 in Slavin, 2006). By knowing the cognitive styles of students, teachers can accommodate cognitive style that is owned by individual students in different learning strategies. Results of previous studies Yecan, Esra (2005) which says that the positive effect on the cognitive styles of learning strategies. But Anzelmo, Nicki and Skelton (2016) showed no statistically significant results that do not affect the cognitive styles of learning strategies.

Based on above explanation it is necessary to examine and analyze (1) The differences between learning outcomes of mathematical problem solving among stundents' groups of who earn a strategy Problem Based Learning (PBL) and Direct Instruction (2) The differences in students' groups problems solving learning outcomes who had a different cognitive style (3) the effect of the interaction between the learning strategies and cognitive styles toward students' mathematical problem solving learning outcomes

II. Method

This research used a quasi-experimental design with nonequivalent control group designs. According to Cohen et al (2011), this method was selected to determine the group treatment whether it was not random, either the experimental group or the control group. The effects of each independent variable and the interaction effect between the independent variables on the dependent variable was analyzed by using statistical analysis of covariance two lanes with a 2x2 factorial design.

The subjects were students of elementary school 5 grade in Surabaya, East Java. The total population of primary school in the town of East Surabaya was as many as 141 public elementary school. The reason assigned a public elementary school for the public elementary schools were more homogeneous than the private elementary school. The school was founded by the religious background foundation. From 141 public elementary school, it was chosen four classes as a research cluster sampling or multistage procedure, which represented a similar academic ability class. The selected schools were schools that had parallel classes, so the circumstances were relatively similar. Fourth grade was selected, it was public Elementary School Gading 1 (4

classes). From these schools were randomly chosen to implement different learning, they were implementing problem-based learning and hands-on learning.

The research instrument which was used to collect the data in this study consisted of two types, they were (1) Problem solving instruments was problem-solving ability test (pretest and posttest) (2) Students' cognitive styles instruments was obtained by using the Group embedded figures test (GEFT), developed by Witkin, et al (1971). Data analysis techniques in this study used ANOVA technique (analisys of variance) two lanes.

III. Results and Discussion

The result were obtained from the students' problem-solving who learned by using problem-based learning strategies and hands-on learning and the second data is the cognitive style description on the problem solving learning results. The results of students' mathematical problem solving pretest showed that the average pretest scores in the group treated with the strategy of problem-based learning (PBL) is 44.04 with a standard deviation of 10.12. In the study group with direct teaching, the average pretest score was 39.18 with a standard deviation of 7.49 can be seen in Table 1.

Table 1 Problem Solving Math Pretest Scores

Descriptive Statistics				
Dependent Variable: Pretest				
Strategy	Cognitive Styles	Mean	Std. Deviation	N
PBL	FI	49,96	8,500	28
	FD	36,50	6,315	22
	Total	44,04	10,124	50
DI	FI	38,12	8,344	26
	FD	40,33	7,493	24
	Total	39,18	7,945	50
Total	FI	44,26	10,265	54
	FD	38,50	7,145	46
	Total	41,61	9,377	100

from the two groups learning strategy, it can be seen that the average pretest both treatment groups were nearly equal, this suggests that the two strategies used in solving mathematical problems of the treatment showed there was no significant difference or no data is distorted or data outlier.

The results of the hypothesis testing of unity tested in this study was the effect of learning strategies for learning outcomes solving mathematical problems, Based on analysis of the data shows that significant price was 0.041 ($p \leq 0.05$), the null hypothesis is rejected so that it can be interpreted there is a difference though was not too signifikant problem-solving learning outcomes between groups of students taught with problem-based learning with a group of students who are taught by direct instruction, presented in table 2.

Table 2 Results of Analysis Anova 2 Land

Tests of Between-Subjects Effects					
Dependent Variable: Posttest					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3239,659[a]	3	1079,886	17,412	,000
Intercept	451322,889	1	451322,889	7276,979	,000
Strategy	267,002	1	267,002	4,305	,041
Cognitive Styles	1825,134	1	1825,134	29,428	,000
Strategy * Cognitive Styles	1294,993	1	1294,993	20,880	,000
Error	5953,981	96	62,021		
Total	470778,000	100			
Corrected Total	9193,640	99			
a. R Squared = ,352 (Adjusted R Squared = ,332)					

The results showed that the implementation of problem-based learning was not more excellent than direct instruction whether implemented in primary school classroom 4. The findings of this study is in line with the findings of previous researchers Albanese and Mitchell (1993), Colliver (2000), and Norman and Schmidt (2000) which concluded that PBL performed no better or worse than direct instruction, though Drake and Deborah (2009), Daniel, Gretchen Elisabeth (2003), stated that the application of the model of Problem Based Learning can increase the motivation for solving the problems facing children learning difficulties.

Strategy of problem-based learning is applied in this research, it still can not be applied in primary school classroom , the lack of effectiveness of this strategy due to the lack of the students' understanding problems on the spot, at the initial meeting learners tend to think heterogeneous, as said Parwati (2011) that apply the weaknesses of problem-based learning in fourth grade elementary school, they were: (1) In some early

meetings, teachers often ask children seek answers to issues presented in the beginning, to get the right answer. In fact, should the problem only as a motivator for students interested in studying the matter further. The correct answer to the problem, should be found by the students when they understand the concept of newly learned material. (2) Time allocation in Mathematics for one meeting only 2 X 35 minutes. so that in one meeting is not enough to discuss the subject until the sub discuss the Student Worksheet. (3) The child egoism is quite high, seen in some of the early meetings, they are difficult to cooperate in solving the problems that need to be trained; and (4) there are still many children who are weak in understanding the material prerequisites. Another weakness is the instructors who are less active in the process also determine the failure of cognitive skill development and teamwork. The same thing also delivered by Tan (2004) which states that the instructor is a facilitator who should be active in the process for PBL. Ali I Alhaqwi (2014) states that most participants believe that PBL had a positive impact on the development of cognitive skills, personal and teamwork them, it depends on the instructor who has two properties, namely: content and process expertise. In their study says that only 53% said that the role of the teacher or instructor is considered necessary for them. Evensen, D., & Hmelo, C. (2000) considers it important that the instructor must be actively involved in learners' cognitive style and facilitate self-reflection. Problem-based learning takes time, patience and practice to understand it (Cain, 2003 in Etherington, Matthew B. (2011). It is because that the change from conventional systems to independence is not easy, it is experienced both learners and teachers as facilitators.

Based on these results, the direct learning strategy is not different from the problem-based learning strategy, because: (1) the teacher controls the content of the material and the order information received by the students so that they can know what you want until where the ability of the students; (2) Teachers can show how a problem can be solved; (3) The teacher can demonstrate the material being studied, so that students do not have to be real because it is already understood. There are some disadvantages encountered in the implementation of direct teaching strategies, especially in facilitating the troubleshooting process, are: (1) the learning success directly depends on the way teachers communicate the material presented thus indirectly readiness, ability and knowledge of teachers be decisive; (2) only the students who listen and understand who can finish the material presented by the teacher, because the teacher must first give examples or demonstrate ways that do in problem solving; (3) to study the concept of the new material, students are less given the opportunity to conduct exploration activities for all students learned the material presented by the teacher; and (4) students rarely get the opportunity to discuss, so the ability to develop ideas and team work are difficult to develop to the maximum.

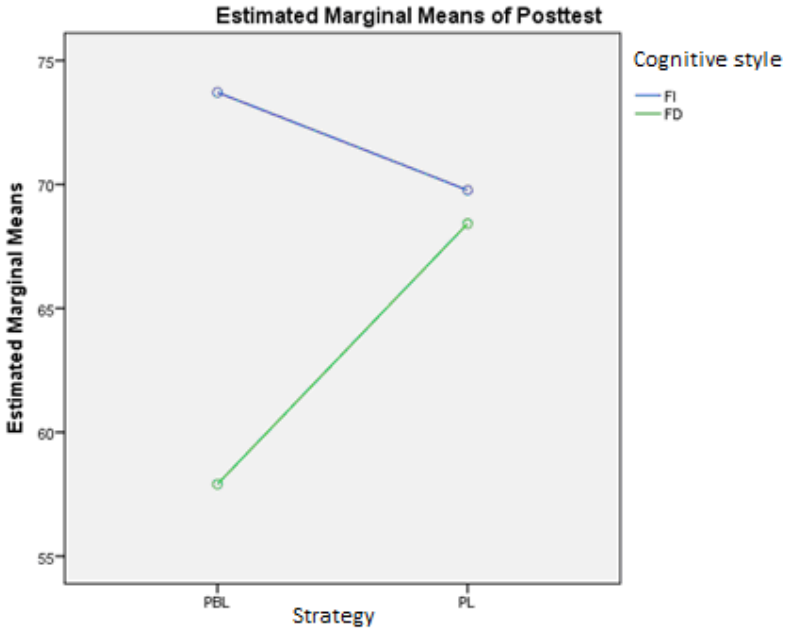
The results of the second hypothesis testing in this study was the effect of cognitive style on mathematical problems solving learning outcomes. Based on the data analysis shows that a significant price is 0.000, ($p \leq 0.05$), the null hypothesis is rejected so that it can be interpreted the significant differences learning outcomes of mathematical problem solving among groups of students who have the cognitive style field independent (FI) with a group of students who has a cognitive style field dependent (FD). There are several findings in this study. The finding states that the cognitive style had no significant difference toward the learning outcomes solving the problem, they were:

First, it shows that students who study with cognitive style field independent (FI) is significantly more excellent to the students who studied with cognitive style field dependent (FD). The average score of mathematical problem solving learning outcomes of students that learned with cognitive style field independent (FI) = 71.40 and an average score of mathematical problem solving learning outcomes of students that learned with cognitive style field dependent (FD) = 63.28. So overall, math problem solving learning outcomes of students that learned with cognitive style field independent (FI) was better than cognitive style field dependent (FD). These findings concur with those of (Sirin & Guzel 2006, Gholami & Bagheri, 2012). The results showed that the students' ability to solve mathematical problems vary depending on their learning style. Aljaberi, Nahil M. (2015), in his research found that there are individual differences in learning styles in the ability to solve mathematical problems. The problems in this study were associated with problems in daily life. Learners who have learning styles field independent (FI) is easier to understand the problem in a given problem, while the participant students who have learning styles field dependent (FD) sometimes misinterpret the problems facing it in visits when given a problem in pretest.

Second, cognitive style field independent (FI) is significantly more excellent to the students who studied with cognitive style field dependent (FD). It happened only in the field of science. Catherine.H.M. Lee et al. (2005) found that students who FD best success with learning tasks socially oriented. This was in line with Saracho, (1998) which states that the FI students prefer to work on a task-oriented abstract and less social. This finding is similar to Okwo and Otubah (2007) and Adeyemi (1992) who found that students in independent field significantly better than the field dependent students in physics and biology. Uchenna Onyekuru Bruno (2015) also concluded that the students' independent field has average achievement higher in science than students dependent field while field dependent students have higher achievement in the arts of student independent field.

The results in this study, the third hypothesis testing is the interaction between learning strategy and cognitive style on learning outcomes solving mathematical problems. Based on the analysis of data shows that a significant price is 0.00, ($p \leq 0.05$), the null hypothesis is rejected so that it can be interpreted there was no interaction between learning strategy and cognitive style on learning outcomes solving mathematical problems,it can be seen in Figure 1. This shows that the group of students who have learning styles field Independent (FI) towards mathematics is better in achieving learning outcomes on mathematics problem solving problem-based learning strategies, than the students' groups who have learning styles field dependent (FD).

Figure 1 The Interaction Between the Learning Strategies Cognitive Style



The results of this research are also consistent with the results of research (Halpern, D., Hanson, C., & Riefer, D., 1990; Stoyanov and Kirschner, 2007) concluded that the cognitive styles were no differences in understanding the problem of that field independent (FI) more increase of the field dependent (FD). While on the direct learning, there is no difference between the groups of students who have learning styles field Independent (FI) and a group of students who have learning styles field dependent (FD). The findings in this study indicate that the strategy implementation problem-based learning needs to consider the cognitive styles of students, because the implementation strategy of problem-based learning correspond to cognitive style. The students will encourage the achievement of learning outcomes solving highly, this is in line with the previous studies Yecan, Esra (2005) which says that the cognitive style affect learning strategies. But Anzelmo, Nicki and Skelton (2016) showed no statistically significant results that do not affect the cognitive styles of learning strategies. Vice versa, if the application of learning strategies are not adapted to the cognitive style, the application of learning strategy will result in lower student learning problem solving or not optimal. While the application of direct instructional strategies was based on the findings in this study, it does not need to consider the cognitive styles of students because there is not any influence on problem solving learning outcomes.

IV. Conclusion

Based on the results of research findings and discussion, it can be concluded as follows: 1) The results of the study was obtained from the data about the students' mathematical problem solving strategies who took problem-based learning was more excellent in achieving learning outcome than the students who took the direct learning. 2) The students' results of mathematical problem solving learning acquired who had cognitive style field independent (FI) was more excellent than the students who had the cognitive style of field dependent (FD). 3) There was an interaction effect toward the learning strategy by using cognitive style on mathematical problem solving learning outcomes,.

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