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Cognitive Style in Computer-assisted Problem Solving Learning Strategies

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***Abstract*—The cognitive style has two poles that show no superiority between the two poles, each pole tends to have a positive value in a particular field and the other tends to have a negative value. This study aims at determining the effect of cognitive style of students consisting of field-independent and field-dependent on the application of problem solving learning strategies computer-assisted in elementary school mathematics learning. This research used experimental method with experiment class of 30 students who have a field-independent cognitive style and control class of 30 students who have a field-dependent cognitive style, and data were analyzed by independent t test. The implementation of problem solving learning strategy in elementary school mathematics learning improves learning outcomes, but the most optimal improvement of learning outcomes is shown in groups of students who have independent cognitive styles, since problem-solving strategies focus on problem solvers that can stimulate students to build their own knowledge through learning processes that requires them to analyze, manage the problem to produce a solution, which is in accordance with the character of students with independent cognitive style.**

Keywords—cognitive style; computer-assisted problem solving; field-independent cognitive style; field-dependent cognitive style

I. INTRODUCTION

Cognitive style as a subject includes several aspects of 'differential psychology' associated with individual differences in the learner and the learning [1]. The cognitive style refers to these characteristics in organizing their environment conceptually [2]. Cognitive style is a learning style that describes the behavior that remains in a person in receiving, thinking, solving problems and store information [3]. The cognitive style has two poles that show no superiority between the two poles, each pole tends to have a positive value in a particular field and otherwise tends to have a negative value in another field [4, 5]. The cognitive style consists of the field-Independent cognitive style and the field-Dependent cognitive style. Subjects who used visual cues were designated "field-dependent", while those used postural (i.e., vestibular, tactile and kinesthetic) cues were designated "field-independent" [6]. One of the characteristics of students who have an independent field cognitive style that is more interested in material related to mathematics and natural science [7]. This should be one of the capital in learning elementary school mathematics to achieve optimal learning outcomes, because the learning of elementary school mathematics requires the creativity of students to formulate their own structure of mathematics learning that will be presented to elementary school students. But the tendency is the students just memorize the concept alone without a thorough understanding of the subject matter. How to learn to make a candidate elementary school teacher who will be tasked to produce quality human resources to answer future needs.

Witkin's discovery in his work "The role of cognitive style in academic performance and in teacher-student relations" indicates that students' cognitive styles influence the way teachers teach and how students learn [7], this means that the selection of learning strategies is worthy of cognitive style students to make optimal students in learning so that the achievement of maximum learning outcomes may be achieved. Studying mathematics in elementary school requires a learning strategy that can stimulate student creativity. Learning that has more impact on improving learning outcomes are student-centered learning [8]. Student-centered learning includes learning with problem solving strategy [9]. Problem solving strategies require students to construct their knowledge through problem solving [10]. Problem solving is the process of taking corrective action in order to meet objectives. more simply put, problem solving is the process of 1) Understanding the contexts in which we work, 2) Setting goals for future performance, 3) Employing data to make meaning of the issues we face, 4) Making choice (decisions) about what we will do to remediate our concerns, 5) Evaluating progress toward our goals, and 6) Using our school system and structures to enhance problem solving out-comes [11]. Problem solving learning strategy has four important elements that is knowing problem, arranging problem solving or organizing problem, executing strategy or solving problem so as to result solution and evaluate and conclude solution become a knowledge. Furthermore, for computer-assisted problem solving learning strategy is a strategy that conditioned the problem as an object to be learned and utilize technological advances, among others, computer in solving the problem. But the existence students are not familiar in the utilization of technology in this case the computer to the maximum in the learning process. Therefore it is necessary to do an analysis of the implementation of problem

solving strategy computer-assisted with attention to student cognitive style in elementary school mathematics learning.

Quinn and Spencer's research, "The Interference of Stereotypes Threat with Women's Generation of Mathematical Problem-Solving Strategies", showed that in the use of problem solving strategies in mathematics learning with regard to stereotypical disorders, gender differences influence the achievement of learning outcomes [12]. This research has similarities with Quin and Spencer research that is researching the application of problem solving learning strategy in learning mathematics in university, and the difference in this research attention to student cognitive style of Field-Independent cognitive style and cognitive style Field-Dependent. Hence, the aims of this study to investigate the influence of cognitive style of students consisting of field-independent and field-dependent on the application of problem solving learning strategies computer-assisted in elementary school mathematics learning

II. METHOD

This research is using experimental method. The dependent variable is the learning outcomes of student in elementary school mathematics course, independent variable is problem solving learning strategy and cognitive style consisting of cognitive style field-independent and cognitive style field-Dependent.

The population in this research is the sixth semester students of the elementary school teacher's education department of education faculty academic year 2017-2018. Sampling was used a quota sampling technique [13] consisting of 30 students with a cognitive style field-Independent in the experimental class and 30 students with a cognitive style field-independent. This research is conducted in the even semester of academic year 2017-2018 in Elementary Teacher education department of education faculty of Universitas Negeri Manado.

Cognitive style data collection techniques were carried out with cognitive style questionnaire consisting of 34 statements using a scale of 1-5 which was built from indicators presented by Witkin, indicator the cognitive style field independent is 1) students who have the ability to organize objects that have not been organized and that have been organized; (2) students who tend to be less sensitive, cold, and like to keep their distance from others, and are individualistic; (3) students who have the ability to analyze in separating objects from the surrounding environment, so that their perceptions are not affected if the environment changes; (4) students who are happy with the profession that can be done individually and if in the learning process they prefer material that is more abstract or requires theory and analysis process ; (5) students who tend to define their own learning goals, and (6) students who tend to work with an emphasis on intrinsic motivation and are more influenced by intrinsic reinforcement. Furthermore, the characteristics of students who have a Field dependent cognitive style are described as follows: (1) students who tend to think globally, view objects as a whole with their environment, so that their perceptions are easily affected by changes in the environment; (2) tend to accept existing structures because they lack the ability to restructure; (3) having a social orientation, so that they look kind, friendly, wise, kind and loving towards other individuals; (4) tend to choose professions that emphasize social skills; (5) tend to follow existing goals; and (6) tend to work by prioritizing external motivation and are more interested in external reinforcement, in the form of gifts, praise or encouragement from others [14].

The techniques data collection of learning outcomes were carried out by 60% practice tests and 40% written tests. Written test in the form of 30 objective questions, with a score of 1 for the correct answer and 0 for the wrong answer, while for the practical test taken with the observation sheet with the maximum score 4. learning outcome test is expected can measure of student competency in accordance with the curriculum that is able to analyze mathematical material in the elementary curriculum, compile learning outcome assessment tools, develop learning strategies, compile and develop technology-based learning media and mathematics learning simulations in elementary schools.

Validity test is done in two forms, namely testing the validity of constructs/content and testing of empirical validity. Testing the validity of the constructs/contents is done with expert analysis and empirical validity testing with the correlation of grain scores with the total score of test results test. Respondent expert review consists of Respondents were asked to provide an assessment of learning outcomes on the following aspects: 1) Question item according to indicator, 2) Problems are clearly defined, 3) The language domain, 4) The formulation of a sentence does not give rise to a double understanding, 5) Material compatibility. After testing the validity of the construct followed by empirical validity testing. The test of the instrument is carried out on the students in elementary teacher education with the number of 30 students in the semester VII who have passed the learning math elementary school courses. Implementation of test questions carried out before the implementation of the experiment and who conducted the trial is a researcher and assisted by a team of lecturers in elementary school teacher education. The formula used to test the validity of written test learning outcomes is the correlation of biserial point, and for practice test is product moment correlation, and for cognitive style instrument is product moment correlation. The conclusion of the test results of validity of the instrument written test learning outcomes are 30 valid questions and 10 invalid questions that are the number 8, 14, 20, 24, 29, 32, 35, 37, 39 and 40, and for practice test is stated all valid items, as well the results of validity test of cognitive style instrument there are 34 items valid and 8 invalid items are questioned number 11, 16, 18, 29 31, 35, 38, 40.

In this research, internal reliability test is done once and using one instrument. The formula used for the written test is Kuder-Richardson 21, as well Reliability test used for product/practice test and creativity instrument is a coefficient of Alpha. The results of the reliability test of the written test show the high reliability because is the value of r11 = 0.8394, for product/practice test show high reliability because is the value of r11 = 0.75369, and cognitive style test showed the reliability is very high because the value of reliability test is 0.854.

Then the learning outcomes data is obtained through 60% practice test and 40% written test. written test in the form of 50 objective questions, with weight 1 for correct answer and 0 for wrong answer, while for practice test taken by wide observation with maximum score 5. Data were analyzed by independent t test using the formula below [15].

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{{s_1}^2}{n_1} + \frac{{s_2}^2}{n_2}}} \quad (1)$$

III. Result and Discussion

The data of the learning outcomes obtained were processed using the help of the SPSS program computer and the output was presented in table 1 and table 2 below.

TABLE I. STATISTIC DESCRIPTIVE

		N	Mean	Std. Deviation	Std. Error Mean
Learning_Outcomes	Cognitie Style Fied Independent	30	85.9277	3.32897	.60778
	Cognitive Style Field Dependent	30	77.7803	4.70395	.85882

The data in Table 1 show that the group of students with cognitive style field Independent has an average learning outcomes 85.9277 and standard deviation 3.32897. As for the group of students with cognitive style field dependent has an average learning outcomes 77.7803 and standard deviation 4.70395.

The data in Figure 1 shows that the learning outcomes of the subjects 'elementary mathematics learning' in groups of students with Independent cognitive style fields are higher than the learning outcomes of groups of students having the cognitive style of the Field Dependent. Descriptively in table 1 it has been seen that there are differences in learning outcomes between the two groups of students, and to be more convincing then the test is continued with an independent t test.

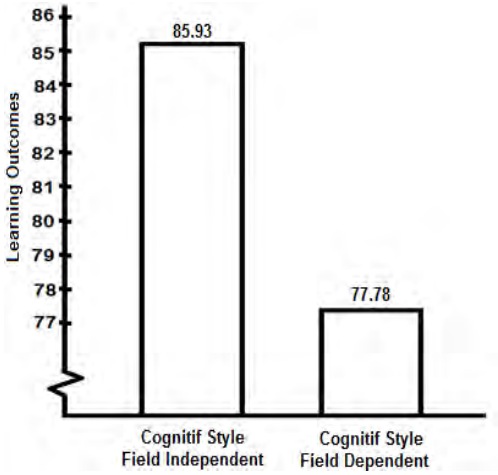

Fig. 1. The average learning outcomes of two group.

TABLE II. INDEPENDENT SAMPLES TEST

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Learning Outcomes	Equal variances assumed	3.241	.077	7.744	58	.000	8.14733	1.05213	6.04127	10.25340
	Equal variances not assumed			7.744	52.223	.000	8.14733	1.05213	6.03630	10.25837

The data in Table 2 column Levene's Test for Equality of Variances shows F_{count} = 3.241 with sig = 0.077> 0.05. This means that the population variance both equal or homogeneous group. Since both groups of homogeneous so the test can be continued by using independent t test formula.

The test results by using independent t test in Table 2 shows the value of t_{count} = 7.744> t_{table} = 2.000 and the value of Sig. (2-tailed) = 0,000 < 0,05. Thus, the proposed hippotesis tested by empirical data that concluded that the study of learning outcomes of 'mathematics elementary learning' course of groups the students with the cognitive style field Independent higher than learning outcomes of students with kognitive style field dependent group.

Learning outcomes obtained by both groups of samples showed the achievement of learning outcomes is quite satisfactory. In the application of computer-assisted problem solving learning strategies, students learn from the activities that occur in the learning process namely activity 1) understand the context in which students work, 2) Set goals for future performance, 3) use data to make meaning from problems that faced, 4) Make choices (decisions) about what is done to solve the problem, 5) Evaluate progress in order to achieve the goals set, and 6) Use the system and existing infrastructure to improve problem solving. Cognitive and affective abilities are a requirement for problem solving, thus in learning one must use strategies that support the development of problem-solving

skills [16]. Through problem solving strategy students are able to build their own experience through the problems presented in the learning process and through the process of discussion they are able to present the solution. Since problem-solving strategies focus on problem solvers that can stimulate students to build knowledge through processes learning that requires them to analyze, manage the problem to produce a solution, which is in accordance with the character of students with independent cognitive style. In line with the results of this study, the results of Kalyuga et al's study proved that inexperienced trainees benefited most of the worked examples conditions. With more experience in the domain, worked examples become redundant and problem solving proved superior [17].

Application of strategy problem solving in the mathematics learning elementary school indeed many encountered obstacles, such as student perspective on problems and different cognitive styles. The findings in this study are in line with the opinion of Gagne et al who recognizes the implementation of strategy problem solving is difficult [18]. The findings in the Sweller study also suggest that sometimes solving problems in problem solving strategies leads only to the goal of the problem not to understanding or learning [19] but with clear instructions it can help the student to understand and construct the problem-solving steps into a good knowledge in the form of cognitive or skill. Likewise, using computer-assisted learning makes it easier for students to solve problems in learning so as to build new knowledge [20].

Characteristics of problem solving learning strategies that emphasize learning on problem solving is one of the factors supporting the acquisition of optimal learning outcomes. The findings or data analysis shows that in the learning that apply computer assisted problem solving strategy, student learning outcomes with independent cognitive style is higher than the student learning outcomes with dependent cognitive style. This is because students with independent cognitive styles are better able to cope with situations that require impersonal analysis while students with cognitive dependent styles are better equipped to deal with situations that require social skills and interpersonal skills [21] especially the characteristics of mathematics learning it is very suitable with the characteristics of students with the Independent field cognitive style [7]. Jonassen's research states that individual differences that vary and control the way the information process will give different effects on the achievement of learning outcomes, it is concluded from the research data showing that students with independent cognitive style is most likely and better interact with problem solving [22]. It is also found in this research where student learning outcomes with independent cognitive style higher than student learning outcomes with cognitive style dependent on learning using problem solving strategy because students with independent cognitive style more able to analyze problem given independently. While for students with dependent cognitive style still requires additional direction or instruction in solving problems in the learning process.

Therefore in elementary school mathematics learning for students with cognitive field dependent styles that applying learning strategies needs more extra assistance by providing additional instruction so that they can spur the students in developing their knowledge concepts.

This study is still limited to measuring differences in learning outcomes achieved by groups of students with Independent field cognitive style and students with cognitive field dependent styles in elementary mathematics learning, and further research is needed to study and analyze more deeply about the factors or causes of differences in achievement of results studied the two groups and also needed further research on the application of other subjects.

IV. CONCLUSION

The implementation of problem solving learning strategy in elementary school mathematics learning course improves learning outcomes, but the most optimal improvement of learning outcomes is shown in groups of students who have independent cognitive styles.

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