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Improvement of Mathematical Connection Ability through Geogebra Assisted Project-Based Learning Model

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Abstract

This study aims to examine the improvement of mathematical connection abilities through a project-based learning model assisted by Geogebra. The research method used was a quasi-experimental design with a pretest-posttest nonequivalent multiple group design. The population is students of the Mathematics Education Study Program at University in West Java, Indonesia. Class 1A and 1B were the samples in this study. The technique of taking the research subject uses purposive sampling. The instrument in this study consisted of a mathematical connection ability test. The test in this study used a pretest and posttest students' mathematical connection ability, and the Group Embedded Figure Test (GEFT). The data analysis technique used independent sample t test and two-way ANOVA test. The results showed that the improvement of students' mathematical connection ability who obtained the Geogebra-assisted project-based learning model was better than students who obtained the project-based learning model and there is no interaction effect of the interaction of learning models and cognitive styles on the achievement and improvement of students' mathematical connection abilities.

Keywords: Geogebra, Mathematical Connection Ability, Project-Based Learning

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Preliminary

The connection ability of students in connecting concepts that have been studied previously is a major problem. Based on preliminary research studies, students' ability in mathematical connections is still low. Some students still have difficulty in relating one concept to another. For example, in determining integrals, students must first understand the concept of algebra and the concept of integral calculus. Thus, the work process in answering questions becomes smooth and makes calculations easier. Findings also occurred in previous research, namely having difficulty in linking concepts between mathematical topics (Rachmani, 2018; Song, 2018). Other findings in previous research said that students' mathematical connection abilities were still low in terms of linking or connecting mathematical topics with other disciplines (Amalia, Lutfiyah, & Permatasari, 2019; Dirckinck-Holmfeld, 2016).

The ability of mathematical connections related to calculus material has already been carried out by researchers. The findings of the research by Solekhah, et al in 2017 are that the connection ability is still low in terms of applying concepts and solving daily problems in the function limit material (Sholekah, Anggreini, & Waluyo, 2017). Likewise, the findings in other studies, namely the achievement of students' mathematical connection ability on Differential

Calculus material is still low. This weak mathematical connection ability is due to learning that does not take place optimally (Caligaris, Schivo, & Romiti, 2015; Suhandri, Nufus, & Nurdin, 2017a).

In several previous studies, the improve in mathematical connections was caused by the use of student center learning, including using a project-based learning model (Dirckinck-Holmfeld, 2016; Maskur et al., 2020; Suherman et al., 2020). The choice of the project-based learning model is because it has several advantages that make mathematics learning more interesting and make learning independent. Some of the advantages of project-based learning include: (1) Improvement motivation; (2) improve problem-solving skills; (3) enhance collaboration; (4) improve resource management skills; (5) improve activity; (6) improve skills in finding information; (7) encourage to develop communication skills; (8) providing experience in project organization; (9) providing experience in making time allocations to complete tasks; (10) providing real-world learning experiences; (11) make the learning atmosphere fun (Grant, 2002; Ratnasari, Tadjudin, Syazali, Mujib, & Andriani, 2018). The combination of learning models with the use of media and multimedia with Macromedia Flash and Geogebra offline applications on some mathematical materials can improve mathematical connection ability (Alfian, Dwijanto, & Sunarmi, 2017; Hu, Wu, & Shieh, 2016; Purwanti, Pratiwi, & Rinaldi, 2016; Ari Septian & Komala, 2019). In the previous description, it is hoped that project-based learning assisted by Geogebra can improve mathematical connection abilities.

Several studies on mathematical connection abilities at the university level have also been carried out. For example, research on mathematical connection abilities by Abidin & Jupri, (2017); Ariawan & Nufus (2018) focuses on the profile of mathematical connection abilities in terms of students' cognitive styles in the Differential Calculus course. Research by Yolanda & Wahyuni (2020) with a focus on improving mathematical connection ability through the application of Accelerated Learning Cycle Learning in Algebra and Trigonometry courses. Research by Rachmani (2018) focuses on the comparison of Improvement students' mathematical connection ability through web-assisted brain-based learning and ordinary learning in the Integral Calculus course. Research by Noto, Hartono, & Sundawan (2016) with a focus on analyzing students' mathematical connection abilities in the Spatial Analytical Geometry course. Research by Hotipah & Pujiastuti (2020) with a focus on analyzing mathematical connection abilities in the Spatial Analytical Geometry course.

Based on several previous studies related to mathematical connection abilities and Geogebra-assisted project-based learning models, the focus of this research is not on Improvement students' mathematical connection ability in the Integral Calculus course. In addition, research on student learning independence using the Geogebra-assisted project-based learning model has not been widely used so that it becomes novelty or there is an element of novelty in this research. The use of Geogebra-assisted project-based learning models to improve mathematical connection ability in Integral Calculus courses is still rare. The urgency of existing research has not led to its relevance to the achievement and improvement of mathematical connection ability. Therefore, this research is focused on filling the part of knowledge that has not been studied.

Research Methods

The type of research used is quantitative method. The research method used in this research is Quasi Experimental. The quasi-experimental research design used in this study was in the form of "Pretest Posttest Nonequivalent Multiple Group Design" which involved two groups of students, namely experimental group 1 and experimental group 2 (Johnson, R. B., & Christensen, 2003). The population in this study were students of the Mathematics Education Study Program level 1 semester 2 for the 2018-2019 academic year. There are 2 classes, namely experimental class 1 (Level 1A) and experimental class 2 (Level 1B) which are used as samples. The technique of taking the research subject uses purposive sampling, which is a sampling method whose selection refers to a specific purpose. The sample selection was based on student characteristics, including students who had almost the same scores in differential calculus and basic mathematics, had the ability to use Geogebra, had adequate facilities, and the level of participation. The instrument in this study consisted of a mathematical connection ability test. The test in this study used a pretest (initial test) and posttest (final test) students' mathematical connection ability, and the Group Embedded Figure Test (GEFT).

Result

Table 1. Results of Independent Samples t Test Data Gain Index Mathematical Connection Ability

t	df	Sig. (2-tailed)
5,650	43	0,000

Based on Table 1, the results of the independent sample t test obtained a significance value of 0.000 <0.05. Thus, it can be concluded that there is a difference between the average

improve in mathematical connection ability of experimental group 1 and experimental group 2. The data in Table 1 shows that descriptively, experimental group 1 and experimental group 2 have different averages, namely 0.63 and 0.25. Thus, it can be concluded that the improvement in mathematical connection ability achieved by students who applied the Geogebra-assisted project-based learning model was better than the students who only applied the project-based learning model.

In the analysis of the effect of the interaction of learning models and cognitive styles on Improvement students' mathematical connection ability, they will be tested through a two-way ANOVA with the assumption that the gain index data with 4 different categories come from a normally distributed population. The results of the normality test are presented in Table 2.

Table 2. Normality Test Results for Improvement Mathematical Connection Ability between Learning Models and Cognitive Styles

Group	Cognitive Style	*Kolmogorov-Smirnov*		
		Statistic	df	Sig.
Experiment 1	*Field independent*	0,259	10	0,057
	Field dependent	0,143	12	0,200
Experiment 2	*Field independent*	0,164	8	0,200
	Field dependent	0,132	15	0,200

Based on the results of the normality test contained in Table 2, the significance value for all groups > 0.05 was obtained, then H_0 was accepted. Thus, it can be concluded that the entire group sample came from a normally distributed population. The results of the homogeneity test using Levene's test are to obtain a value of F = 1.991 and a value of sig. = 0.130. Thus, it can be concluded that the data is homogeneous or has the same variance. Furthermore, it will be tested using Anova Two Paths. The hypothesis being tested is that there is an interaction effect of learning models and students' cognitive styles on Improvement students' mathematical connection abilities.

Table 3. Interaction Test Results between Learning Models and Cognitive Styles on Improvement Mathematical Connection Ability

Source	Sum of Squares	Df	Average Square	F	Sig.
Learning Model	1,598	1	1,598	33,949	0,000
Cognitive Style	0,023	1	0,023	0,493	0,487
Interaction	0,125	1	0,125	2,654	0,111
Adjusted R Square x 100 % = 43 %					

In Table 3, it is found that: (1) on the learning model factor, the significance value is <0.05, then H_0 is rejected. This shows that there is a significant direct influence of learning model factors on Improvement students' mathematical connection abilities; (2) on the cognitive style factor, obtained a significance value > 0.05, then H_0 is accepted. This shows that there is no significant direct effect of cognitive style factors on Improvement students' mathematical connection abilities; and (3) the effect of the interaction obtained a significance value > 0.05, so that H_0 is accepted. Thus, it can be concluded that there is no interaction effect of learning models and cognitive styles on Improvement students' mathematical connection abilities.

Discussion

The achievement and improvement of students' mathematical connection ability who apply the Geogebra-assisted project-based learning model is because the Geogebra-assisted Project-based learning model is a learning model that provides opportunities for students to find information according to phenomena related to Integral Calculus, plan, implement, display project results in Geogebra form, and evaluate the project results (A. Septian, Darhim, & Prabawanto, 2020). In addition, student knowledge improves due to experience when learning, interaction and communication occurs between students, and communication occurs between students and lecturers (Kennedy, Lee, & Fontecchio, 2016). The group activities in the implementation of project-based learning assisted by Geogebra occur dynamically and can elaborate on the results of their work. According to the theory from Dewey (1916); Dirckinck-Holmfeld (2016) which states that project-based learning provides experiences, activities, interactions between students, interactions between students and teachers/lecturers. Several learning theories are applied to the Geogebra-assisted project-based learning model, namely the cognitive development theory of Piaget and Bruner. According to Piaget in (McLeod, 2015), cognitive development is largely determined by the manipulation and active interaction of children with the environment. In line with that, Conway (2007) argues that knowledge is obtained through children's active participation in learning, learning experiences, and experimenting with problems that occur. In the end, the achievement and improvement of students' mathematical connection ability who applied the Geogebra-assisted project-based learning model was better than students who only applied the project-based learning model.

In this era, technology has become one of the requirements in the world of work. Educators are required to master teaching materials, learning models, and technology-based multimedia (Hallal et al., 2016; Mohd, Shahbodin, Sedek, & Samsudin, 2020). The importance

of technology-based multimedia has a positive impact on the learning process and student learning outcomes (Ari Septian, Darhim, & Prabawanto, 2021; Song, 2018). Geogebra is one of the software that can be used for free and easily, and is complete in algebra, geometry, statistics, and others (Del Cerro Velázquez & Méndez, 2021; Poon & Wong, 2017; Yildiz, 2018). Geogebra can also be used in integral calculus material, students feel helped by this Geogebra. The problem of making graphs that became the background of the problem when found in observations was resolved well. For example, students can create a graph of a mathematical equation or data (Caligaris et al., 2015).

The research findings show that there is no interaction effect of learning models and cognitive styles on Improvement students' mathematical connection abilities. This is in line with the findings from the research of Firdausi, Inganah, & Putri Rosyadi (2018) which states that the improve in mathematical connection ability is not influenced by the interaction of learning model variables and cognitive styles. Based on this explanation, it can be concluded that the learning model factors and cognitive style factors together have no direct effect on Improvement students' mathematical connection abilities, which means that there is no difference in the average improve in students' mathematical connection abilities in terms of interaction factors between learning models and cognitive styles. the difference in the improvement of students' mathematical connection abilities which can be explained by the variability of the learning model factors and cognitive style factors and the rest is influenced by other factors. The absence of the interaction effect of learning models and cognitive styles on improving students' mathematical connection ability is because students with field independent cognitive styles are either given treatment with the Geogebra-assisted project-based learning model or those who are treated with project-based learning models already have the habits they do. Some of them have the ability to analyze to separate objects from the surrounding environment, so that their perceptions are not affected when the environment changes. In addition, the majority of the group of students with field independent cognitive style had an improve in students' mathematical connection abilities with good criteria.

The findings in this study also show the influence of the learning model on Improvement students' mathematical connection abilities. This is because the application of the Geogebra-assisted project-based learning model or those that do not use Geogebra has a positive impact on motivation, activity, independent learning, and social interaction. In accordance with Dewey (2012) that student center learning provides motivation to students in the learning process. In learning the project-based learning model provides experience and interactions occur between

students. In another theory, according to Piaget in (Alamolhodaei, 2009; McLeod, 2015), cognitive development is largely determined by the manipulation and active interaction of children with the environment. In line with that, argues that knowledge is obtained through children's active participation in learning, learning experiences, and experimenting with problems that occur (Barnard et al., 2018). In the end, students' mathematical connection ability experienced a significant improve, both applying the Geogebra-assisted project-based learning model or only applying the project-based learning model .

The next finding is that cognitive style affects the improvement of students' mathematical connection abilities. Students with field independent cognitive style have better scores than students with field dependent cognitive style. This is in line with the findings in Ariawan & Nufus (2018) which concluded that students with field independent cognitive styles were better than field dependent cognitive styles. Starting from the learning process based on projects that are independently carried out by each group or individual, it is Improvementally distinguishing the ability of mathematical connections in different cognitive styles. This is because students with field independent cognitive style tend to be able to solve problems independently without waiting for others, so that their knowledge improves and leads to the achievement of better mathematical connection abilities. According to the theory of Witkin in Udiyono & Yuwono (2018), the influence of student cognitive style is more on the habit of learning independently or depending on others. The characteristic of field independent is that students do not depend on the learning environment in the classroom and do not depend on other students when learning. Meanwhile, the characteristic of field dependent causes students to be very and always dependent on the learning environment and other people (Ma'rufi, Pasandaran, & Yogi, 2018; Vendiagrys & Junaedi, 2015).

The other factors that influence the improvement of mathematical connection ability are students' prerequisite skills such as differential calculus, basic mathematics, two-variable algebraic equations and geometry (Korenova, 2017; Poon & Wong, 2017). The ability of mathematical connections is influenced by other factors such as the ability of prerequisites that are still not qualified. The previous material must be mastered well so that the process of working on the questions becomes easier. Another factor that determines the ability of mathematical connections is the mastery of geometry and the ability to solve everyday problems (Amaliyah AR & Mahmud, 2018; Kennedy et al., 2016) .

Conclussion

Based on the results and discussion, it can be concluded that the improvement of students' mathematical connection ability who received the Geogebra-assisted project-based learning model was better than the students who received the project-based learning model and there was no interaction effect between the learning model and cognitive style (Field independent (FI) and Field dependent (FD)) on Improvement students' mathematical connection ability.

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