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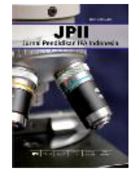

THE INFLUENCE OF V DIAGRAM PROCEDURAL SCAFFOLDING IN GROUP INVESTIGATION TOWARDS STUDENTS WITH HIGH AND LOW PRIOR KNOWLEDGE

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ABSTRACT

The learning achievement of high school students of Malang city in physics was still low, thus the appropriate learning strategies was necessaryto optimize the physics learning achievement. V diagram procedural scaffoldingin Group Investigation was designed with the aim to optimize student learning achievement. The purpose of this study was to examine differences in learning achievement of groups of students who learn through Scaffolding Procedural strategies in Group Investigation and groups of students who are studying with Group Investigation, to examine differences in student achievement between thosewith high and low prior knowledge levels, and to examine the interaction between learning strategies (procedural scaffolding in GI and GI) and initial knowledge of students towardlearning achievement. The method used in this study wasquasi-experimental.The design used in this study was Two Factorial Design consisted of two experimental classes and two control classes each. The results indicated that learning achievement group of students who learn through proceduralscaffolding in Group Investigation was higher than the group of students who are studying with Group Investigation. The learning achievements of students with high prior knowledge surpassed those with low prior knowledge. Last, there was an interaction between the learning strategies and prior knowledge of students toward learning achievement.

Keywords: Group Investigation, Learning Achievement, Prior Knowledge, Procedural Scaffolding, V Diagram.

INTRODUCTION

The learning achievement is a major factor for the success of a lesson. The learning achievement is of paramount importance in determining the quality of students. However, academic achievement of senior high school students in Malang in physics was still low. This could be seen from the results of a national exam results which suggested that the average score of physics in Indonesia was not yet satisfactory. Average results of physics National Examination in Malang was lowest (Malang City 32, Malang regency 34, and Batu 38) among 38 cities and regencies in East Java (BSNP, 2013).

This wasprobably caused by teachers provide inappropriate learning related with students' prior knowledge in which some had high prior knowledge, but others were low. Students with higher prior knowledge tend to score higher than students whose prior knowledge initially low (Laili, 2014). Koes (2013) also reported that students with higher level of initial knowledge obtained a higher average physics score than those with low initial levels of knowledge. Students who hadsufficient prior knowledge would be able to follow the learning process well, causing them to get better learning results.

In a real class, students' prior knowledge varies greatly and making it difficult for teachers in implementing the learning activities. Variations of initial knowledge should serve as a guideline for giving lessons. As the result, a teacher might not be able to provide appropriate learning to each student with different initial knowledge

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because of the large number of students in the class. This obstacle can be overcomed by the provision of scaffolding.

Scaffolding is a way to facilitate various initial knowledge levels of students in the class. Puntambekar & Hubscher (2005) states that the scaffolding can help students to resolve complex problems, provide a structure for organizing scientific arguments and explanations, or further highlight the process of science. Scaffolding can also help teachers in the classroom which all groups cannot be monitored every time.

Procedural scaffolding is a relief that utilizes the available resources and tools (Yu et al., 2013). Procedural scaffolding isseries of procedural steps that must be passed and followed by the students. It also includes sequences that will be pursued in the search for a solution through experiments. Procedural scaffolding is used to guide students in doing experiments in the laboratory. Procedural scaffolding can improve their understanding of physics concepts (Laili, 2014) and the quality of student questions (Yu et al., 2013).

V diagram is one of the procedural scaffolding. V diagram helps students to link the concepts of science and designing investigations (Knaggs & Schneider, 2012), making learning more meaningful and effective, developing communication skill and scientific processing skills (Keles & Ozsoy, 2009). V diagram is an ideal tool to help students understand how a concept can be related to the others (Calals, 2009). V diagram can also develop students' knowledge in an organized and meaningful way (Tekes & Gonen, 2012).

V diagram can be applied in various learning, one of which is the cooperative learning. Jbeili (2012) suggests that the cooperative learning with scaffolding can improve conceptual understanding and procedural capabilities. O'Donnell et al. (2002) also added that students who use scaffolding on cooperative learning can learn more effectively. In cooperative learning, students will learn more effectively when they actively engaged in sharing ideas and working together to accomplish a task (Ebrahim, 2012). Pickles and Tarhan (2008) discovered that during the discussion during cooperative learning, students use their prior knowledge and experience, to think, to discuss, to share knowledge, and to apply the concepts acquired in a variety of other conditions.

One model in cooperative learning is the Group Investigation (GI). Group Investigation is a cooperative learning strategy in which students work in small groups to investigate a topic of learning (Kagan &Kagan, 2009). When the GI modelis applied in the classroom, the studentsare responsible for choosing their own topic of inquiry, problem formulation, planning and conducting investigations in various ways, and sharingtheir findings (Oh & Shin, 2005). Therefore, GI model can optimize students' achievement.

The study consisted of three focuses: (1) How is the learning achievement of a group of students who learn through Procedural Scaffolding strategy in Group Investigation compared to the group of students who are studying with only Group Investigation (2) How is the learning achievement of students who have a higher prior knowledge than group students who have a low level of prior knowledge (3) Is there any interactions between the learning strategies (procedural scaffolding in GI and pure GI) and initial knowledge of students toward student achievement.

METHOD

The method used in this study is a quasi-experimental method (Quasi Experimental Design). The design of the study was Two Factorial Design consisted of the experimental group and the control group. The difference in treatment between the experimental class and control class laid in the applied model to both classes. The experiment class would useProcedural Scaffolding in Group Investigation, while the control class only applied Group Investigation model.

The study population was students ofscience classes XI of SMA N 3 Malang in academic year 2015/2016 who are divided in seven parallel classes. The sample in this study was taken using cluster sampling technique. This study used samples of 2 experimental classes and 2 control classes. Two classes of experimental were XI MIA 1 and XI MIA 2, while the two control classes were XI MIA 3 and XI MIA 4. The free variable in this research was the Procedural Scaffolding in Group Investigation and GroupInvestigation, while the dependent variable was the learning achievement. The moderator variable was the initial knowledge.

The instrument used in this study consisted of treatment instruments and measuring instruments. The treatment instrument is procedural scaffolding students worksheet Scaffolding in the form of Vdiagram. The measurement instruments were the initial knowledge tests and achievement tests.Initialknowledge test was used to determine students' prior knowledge before the experiment, thus we achieved data showed groups of students with low initial knowledge and groups of students with high prior knowledge. In this study, we recorded students' initial knowledge of physics in vectors, Newton's law, energy and effort. The achievement test was material dynamics of rotation in multiple choice format. Before applied, the entire instrumentswere validated by two expert lecturers and the questions were tried out.

Test analysis consisted of normality and homogeneity tests. The analysis was performed using SPSS 16.0 for Windows with Kolmogorov-Smirnovmethod. Homogeneity test was performed using Levene test through One WayAnova. Afterthe premilinary analysis was completedand the target was met, then the hypothesis was tested using by two lanesAnova. Hypothesis test was to test the differences in student achievement after studied using Procedural Scaffolding on GI and pure GI, as well as to see the interaction between the learning using Procedural Scaffolding on GI and prior knowledge on student achievement.

RESULT AND DISCUSSION

Description of Prior Knowledge Data

The initial knowledge test was given to 59 students of experimental class and 62 students of control class. Data from this test wasthen sorted from the biggest score to the smallest one. Furthermore, the initial knowledge test result data were grouped into high initial knowledge and low prior knowledge groups. Grouping of initial knowledge based on the combined average score of all classes resulted of 13.04. Based on the classification, 74 students had high prior knowledge and those with low prior knowledge amounted for 47 students. The number represented the combined students of experimental classes and control classes. In experimental classes, there were 33 students with high prior knowledge and 26 students with low prior knowledge. While there were 35 high prior knowledge students and 27 students with low prior knowledge in control classes. The statistic of prior knowledge data can be seen in Table 1.

Based on Table 1, the initial knowledge score in the experimental class with 59 respondents had a minimum score of 6.00, maximum score of 25.00, average score of 13.28, and a standard deviation of 3.73. Prior knowledge on the control class with 62 students obtained a minimum score of 6.00, maximum score of 22.00, average score of 12.81, and a standard deviation of 3.54. Based on the table, we could conclude that the average prior knowledge score in the experimental class at 13.28 was higher than the average score of prior knowledge in control class at 12.81.

Description of the initial knowledge data of experimental classes and control classes grouped into high prior knowledge and low prior knowledgewere summarized in Table 2.

According to table 2, the high prior knowledge students in experimental classes high with the amount of 33 students hadminimum score of 13.00, maximum score is 25.00, average score of 15.54, and standard deviation score of 3, 39. While 26 low prior knowledge students in experimental classesresulted on minimum score of 6.00, maximum score of 12.00, average score of 10.42, and standard deviation score of 1.53.

35 students with high prior knowledge in control classesachievedminimum score of 13.00, maximum score of 22.00, average score of 15.08, and standard deviation score of 2.67. While as many as 27 students with low prior knowledge in control classesgot minimum score of 6.00, maximum score of 12.00, average score of 9.85, and standard deviation score of 2.03.

Based on Table 2 can be explained that the average score of high prior knowledge in experimental classesat 15.54 wasbetter than the high initial knowledge students in control classesat 15.08. In addition, the average score of low initial knowledge in the experimental classes at 10.42 wasalso better than those on control class at 9.85.

Description of Learning Achievement Data

The data were obtained from learning achievement instruments in the form of 16 multiple choice questions with the material of the rotational dynamics and rigid body equilibrium. Learning achievement test was conducted after the treatment completed. This test was conducted for 75 minutes. The description of learning achievement data in the experimental classes and control classescould be seen in Table 3.

Based on Table 3, the learning achievement of 59 students in experimental classesproduced minimum score of 8.00, maximum score of 15.00, average score of 10.36, and standard

Table 1. Statistical Description of Prior Knowledge Data

	N	Minimum	Maximum	Mean	Std. Deviation
Experimental classes	59	6.00	25.00	13.2881	3.73266
Control classes	62	6.00	22.00	12.8065	3.54752

Table 2. Statistical Description of Students with High Prior Knowledge and Low Prior Knowledge

	N	Minimum	Maximum	Mean	Std. Deviation
High prior knowledge experimental classes	33	13.00	25.00	15.5455	3.39200
Low prior knowledge experimental classes	26	6.00	12.00	10.4231	1.52769
High prior knowledge experimental classes	35	13.00	22.00	15.0857	2.67198
High prior knowledge experimental classes	27	6.00	12.00	9.8519	2.03250

Table 3 Statistical Description of Learning Achievement in Experimental and Control Classes

	N	Minimum	Maximum	Mean	Std. Deviation
Experimental classes	59	8.00	15.00	10.3559	1.71969
Control classes	62	6.00	13.00	9.7581	1.93912

Table 4 Statistical Description of Learning Achievement Data of High and Low Prior Knowledge in both Experimental and Control Classes

	N	Minimum	Maximum	Mean	Std. Deviation
High prior knowledge experimental classes	39	8.00	15.00	10.4615	1.86161
Low prior knowledge experimental classes	20	8.00	12.00	10.1500	1.42441
High prior knowledge control classes	35	8.00	13.00	10.8000	1.38903
Low prior knowledge control classes	27	6.00	12.00	8.4074	1.71552

deviation of 1.72. Meanwhile, the learning achievement of 62 students in control classes obtained minimum score of 6.00, maximum score of 13.00, average score of 9.76, and a standard deviation of 1.93. Based on the table it can be explained that the average score of the learning achievement in the experimental class at 10.36 is higher than the average score of the learning achievement in the control class at 9.76.

Description of achievement data of both classes grouped into high prior knowledge and low prior knowledge were listed in Table 4.

In table 4, we can observe the learning achievement of 39 students with high prior knowledge in experimental classes gained minimum score of 8.00, maximum score of 15.00, average score of 10.46, and standard deviation score of 1.86, while learning achievement of 20 low prior knowledge students in experimental classesreceived minimum score of 8.00, maximum score of 12.00, average score of 10.15, and standard deviation score of 1.42.

The learning achievement of 35 students with high prior knowledge in control classes gained minimum score of 8.00, maximum score of 13.00, average score of 10.80, and standard deviation score of 1.39, while learning achievement of 27 low prior knowledge students in control classesreceived minimum score of 6.00, maximum score of 12.00, average score of 8.41, and standard deviation score of 1.72.

The average learning achievement score of students with high initial knowledge in the experimental classesat 10.46 was higher than those in the control class at 10.80. Also, the average learning achievement score of studentswith low initial knowledge of the experimental classat 10.15 was higher than those in control classesat 8.41.

Normality and Homogeneity Tests

Based on the test of normality using Kolmogorov - Smirnov on learning achievement scores, the experimental classes learning achievement scores were normally distributed with significance of 0.233> 0.05 and the control classes learning achievement scores were also normally distributed with significance of 0.352> 0.05. Based on the analysis the researchers concluded that the distribution of learning achievement data in both experimentaland control classes were normally distributed and metthe intended requirements.

Based on homogeneity test using Levene's test, thelearning achievement in the experimental and control classes were homogeneous with significance of 0.26> 0.05. Based on the results of this analysis the test prerequisites were met.

First Hypothesis Test Result

Two line ANOVA analysis resulted on $F_{count}$of 5,228 with a value of 0,024 < 0.05. It can be concluded that the null hypothesis (Ho) was rejected, meaning that the learning achievement of groups of students who learned using Procedural Scaffolding in Group Investigation were different with a group of students studying with only Group Investigation. The average scores of learning achievement of groups of students who learned through the Scaffolding Procedural with Group Investigation at10.36 was higher than the group of students studying with Group Investigation at 9.76.

Learning usingV diagram procedural scaffoldingprovided an opportunity for students to have discussion. Formation of each group of students with heterogeneous prior knowledge could help the interaction between friends in a group. Students with high prior knowledge could assist students with low prior knowledge. The interraction could facilitate students to build knowledge together, so they could get higher learning achievement.

The interaction occured in a class could help students in improving learning achievement. Fatokun & Omenesa (2015) states that classroom interaction can increase students' interest andmaterial understandingleading to higher learning achievement. In addition, teachers also need to connect students' initial knowledge with the learning process to help students to understand science concepts.

V diagram procedural scaffolding strategies in GI brought positive impact on learning achievement. That was because this strategy provided an excellent mean for students to engage fully in dialogue to solve the problem with high success rate. This engagement clearly supported the increase in student achievement.

The results of classroom observations on learning using procedural scaffolding in GI showed that students could explain the relevance within practicum and the material to be studied. Based on the results, students were able to explain some of the related material. Moreover, students could develop the results obtained. In addition, during the learning process students' curiosity in procedural scaffolding V diagram in GI was very visible since students often asked the about the materials rather than the procedures during practicum.

Students who solely studied using Group Investigation could only explain the achieved data afterpracticum. Studentscouldnot develop the research result. They also did not have high curiosity because when the teacher gave reinforcement material, students simply observed and recorded without any question.

This research was supported by the findings of Cagiltay (2006) who found that the procedural scaffolding supports the design and develops self-learning activities. Yu et al. (2013) found that the use of procedural scaffolding supports students in learning activities. The results of students who use procedural scaffolding are better than students without using scaffolding-procedural (Yu et al., 2013). Hsu et al. (2014) revealed that the scaffolding greatly assists the process of investigation and the developmentof understanding toward a concept.

Results of Second Hypothesis Tests

Test results obtained from analysis of two lanes variance $F_{count}$was 19.39 with significance of 0.00 < 0.05. It can be concluded that the null hypothesis (H_o) was rejected, meaning that the learning achievements of students with high of prior knowledge were different from those with low prior knowledge. From the average score of all students, it could be concluded that the average score of students' learning achievement with high prior knowledge at 10.62 was higher than the group of students studying with Group Investigation at 9.15.

The results of observations in the classroom displayed that the students with high initial knowledge showed tendency to dominate the class. The students seemed to pay serious attention to the learning process and askedanything they had not yet understood. When teachers askedthem tosolve the problems, students with high prior knowledge gave direct response and did the tasks.

High prior knowledge students often askedmore complex questions. This was in line with Taboada & Guthrie (2006) that students' questionsare positively associated with reading ability. Students with high initial knowledge in particular domain tended to have a better question proportion or higher level questions than those with low prior knowledge.

Prior knowledge is a prerequisite to learn new knowledge. The more relevant the prior knowledge of the students, it wouldease them to learn new things. Prior knowledge is a prerequisite occurrence of meaningful learning. Initial knowledge can serve as a foundation of learning that can help students' understand a concept.

High initial knowledge students wouldfind it easy to transfer the knowledge they possessed to receive new knowledge and applied the physics concepts in a problem that required some variation and suggested new things. Low initial knowledge students still had difficulty to suggest some variation and novelty related to the concept of physics. Thompson & Zamboanga (2004) stated that prior knowledge affects students in accepting new knowledge. Pror knowledge influences a person's response whenfacing new situations and contributing to learning of new knowledge.

Ionas et.al. (2012) states that when students have an understanding of separated concepts, when trying to accept new information, they do not pay attention to the relationships between concepts, thus students understand the new concepts separately and are not able to connect between concepts. Therefore, in case of learning new knowledge, students should look for the circumstances, concepts or processes in theirmind to construct new knowledge or to solve new problems.

Seery (2009) states that the initial knowledge has a strong influence on student performance. It essentially constructsstudents' frame of mind. In addition, students with high initial knowledge will have the better confidence and tend to have a positive attitude. Ionas et.al. (2012) stated that prior knowledge impacts on the effectiveness of self-explanation in solving chemistry problem. The higherthe initial chemical knowledge, the strongerhis self-explanation will get. Meanwhile, students with low initial knowledge will experience difficulty in doing self-explanation.

Third Hypothesis Test Results

The analysis oftwo lanes variance test resulted on $F_{count}$of 11.48 with significance of 0.001 < 0.05. It could be concluded that the null hypothesis (H_o) was rejected, meaning that there was an interaction between the learning strategies and students' prior knowledge to the learning achievement.This might occur because theV diagram procedural scaffolding provides the opportunities for students to understand and solve the problemsby themselves. All students were given equal chances to be actively involved in the learning process, to take part ininvestigating subtopics, and discussions. In discussion, students of both high and low prior knowledges help each other to construct new knowledge together. This optimal involvement caused the V diagram procedural scaffolding strategy in GI could influence on student learning achievement of physics.

Observation results showed that in the learning usingV diagram procedural scaffolding in GI, students withhigh prior knowledgeable were faster in investigating sub topic by following the scaffolding listed on the students' worksheet those with low prior knowledge, thus it enabled them to help others in their groups. In addition, students with low initial knowledge solved the problems with the help of high prior knowledgestudents. That is why,students with high prior knowledge indirectly increased students with low prior knowledge's physics learning achievement. This ultimately caused the difference in learning achievement among students with high and low initial knowledge.

These results are consistent with a study by Reisslein et al. (2007) who found that there isinteraction between prior knowledge and learning strategies.Reisslein also stated that the engineering students with high prior knowledge on basic electrical circuits showed better learning achievement in problem solving tasks than students with low initial knowledge.

CONCLUSION

Based on the general description, hypothesis testings, and discussion the researcherscouldput forward three research conclusions as follows: (1) The learning achievement of groups of students who learn through Procedural Scaffolding strategies in Group Investigation was higher than the group of students studying with Group Investigation. This wasevidencedby the test results obtained from two lanes Anova with $F_{count}$of 5,228 with significance of 0,024 < 0.05. (2) The learning achievement of students with high initial knowledge was higher than those with low prior knowledge. This was proven from the test results obtained with two lanes Anovawith $F_{count}$of 19.39 with significance of 0.00 < 0.05. (3) There was interaction between the learning strategies and prior knowledge toward learning achievement. This wasshowed from the analysis of test results by two lanes Anovawith $F_{count}$of 11.48 with significance of 0.001 < 0.05.

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