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Empirical Abductive Learning Cycle Model in Improving College Students' Problem Solving Skill in Basic Physics

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Abstract. This study aims to determine the effectiveness of the use of empirical abductive learning cycle models in an effort to improve problem solving skills in students participating in basic physics lectures. The method used is a quasi-experimental method with the design of "Randomized Control Group Pretest-Posttest Design". The study population was students who took basic physics courses at the Faculty of Mathematics and Natural Sciences, Jakarta State University. The study sample was taken in two classes. The experimental class got the abductive cycle learning model and the control class got the conventional learning model. Research data were collected through research instruments in the form of problem-solving ability tests in the form of essays. Conclusions are drawn based on the results of the analysis with processing techniques using the SPSS program. The results showed that the use of empirical learning cycle learning models can significantly improve student's problem solving abilities compared to the use of conventional learning models. The average problem solving ability of n-gain for the experimental class is 0.65 (medium category) and the control class is 0.35 (medium category). From the comparison of the average n-gain concept mastery and problem solving abilities in the two classes, it shows that the application of the learning cycle learning model empirically is more effective in improving problem solving skills than the application of conventional learning models.

INTRODUCTION

Learning approaches will be more meaningful for students if they relate students' initial conceptions to new concepts being studied [1]. In the view of constructivism, learning success depends not only on the environment or learning conditions, but also on students' initial knowledge. Learning involves forming students' meanings from what they do, see, and hear. One teaching strategy for implementing constructivism is the use of a learning cycle or learning cycle. The learning cycle is grouped into three types, namely descriptive, empirical abductive, and hypothetical deductive. An important difference found in these three types is the level of student effort to describe the traits or generalize explicitly to test alternative hypotheses [2].

The empirical abductive learning cycle is descriptive and there is an attempt to give birth to a temporary answer or guess to explain the results of his observations. This cycle requires the use of abduction to transfer terms and concepts learned in other contexts to new contexts. In practice, the learning model of the learning cycle is divided into three phases, namely the exploration phase, the concept recognition phase, and the concept application phase. Through learning the correct learning cycle will be able to build meaningful concepts and confidence in solving problems and making careful decisions [9] [10] [11]. The learning cycle model is a strategy or learning model developed based on a constructivist view. The learning cycle can broaden and improve the level of thinking [4]. This model was first proposed by the USA Science Curriculum Improvement Study (CSIS) in 1970.

Learning cycle models are classified into three type's namely descriptive, empirical abductive and deductive hypothetical [3]. An important difference between the three is the level of ability of students in an attempt to describe the nature or explicitly generate and test alternative hypotheses [5]. The empirical abductive learning cycle is intermediate, requiring descriptive reasoning patterns, but generally involves higher-order thinking patterns. In the empirical abductive learning cycle students find and provide an empirical pattern in a special conceptual exploration,

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they then express possible causes about the occurrence of these patterns [6] [7]. This involves abduction, namely the use of analogy reasoning to move or lend concepts or ideas from past experiences that have been learned in other contexts in new context concept recognition, to get the desired hypothesis. These concepts can be introduced by students, educators or both [13]. With the guidance of educators, students analyze the data collected during the exploration phase to see whether the causes are hypothesized steady with data on other known phenomena application of concepts [14] [15]. Learning that begins with the question "what" and is followed by making hypotheses to express the cause and then test the cause, is called the empirical abductive learning cycle.

METHOD

The method used in this study is a quasi-experiment method. To get a picture of improving the ability of problem solving, a quasi-experimental method is used with the "randomized control group pretest-posttest design" design [12].

TABLE 1. Research Design.

Class	Pretest	Treatment	Posttest
Experiment	O	Empirical abductive learning cycle learning models	O
Control	O	Conventional learning model	O

RESULT AND DISCUSSION

The population of this research is students who take a basic physics lecture in Biology Education Study Program. The study sample was taken two classes chosen randomly as an experimental class with 32 students and a control class with 35 students. The experimental class gets the empirical abductive learning cycle learning model while the control class gets the conventional learning model. The instrument in this study is in the form of an essay test to measure students' problem solving abilities in solving problems related to everyday life. The problem solving test developed was in the form of essays totaling 9 items. To measure the ability of students 'problem solving before receiving treatment of empirical abductive learning cycles and conventional learning, a pretest was conducted while to measure the students' problem solving abilities after getting treated posttest. These test items are consulted with a supervisor, assessed by an expert, and tested.

Description of Improved Troubleshooting Capabilities

Improvement of students' problem solving skills is obtained from the results of the pretest and posttest after participating in learning. The results of the assessment of problem solving skills in the form of scores are then calculated the percentage. Percentage of average achievement score of pretest, posttest and <g> ability to solve problems between the experimental class and the control class can be seen in Fig. 1.

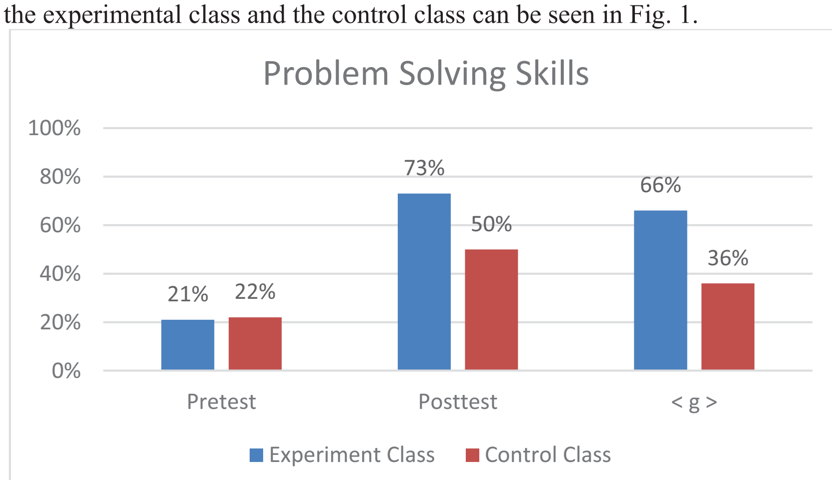

FIGURE 1. Average scores pretest, posttest and <g> problem solving abilities of the experimental class and the control class.

Based on the acquisition of pretest, posttest, and <g> average score data as seen in Fig. 1, it is known that the average score of pretest scores of experimental class students is 21% of the ideal score, while the percentage of pretest average scores in the control class is 22% of the ideal score. The percentage of the posttest average score of the experimental class students was 73% of the ideal score and the percentage of the average score of the control class students was 50% of the ideal score.

The average acquisition <g> ability of problem solving for the experimental class of 0.65 which is categorized as moderate. The average <g> problem solving ability for the control class is 0.35 which is categorized as moderate. The average <g> experimental class is higher than the average <g> control class, but both are included in the medium category.

Description Improved Problem Solving Capability Based on Concept Labels

Basic Physics Concepts measured in students' problem solving abilities consist of four concept labels, they are Kinematics in One Dimension, Kinematics in Two Dimensions, Force and Newton's Laws of Motion, also Work and Energy. Whereas other Basic Physics concept material labels are still being carried out further studies. Comparison of the problem solving abilities for each concept label can be seen in Fig. 2.

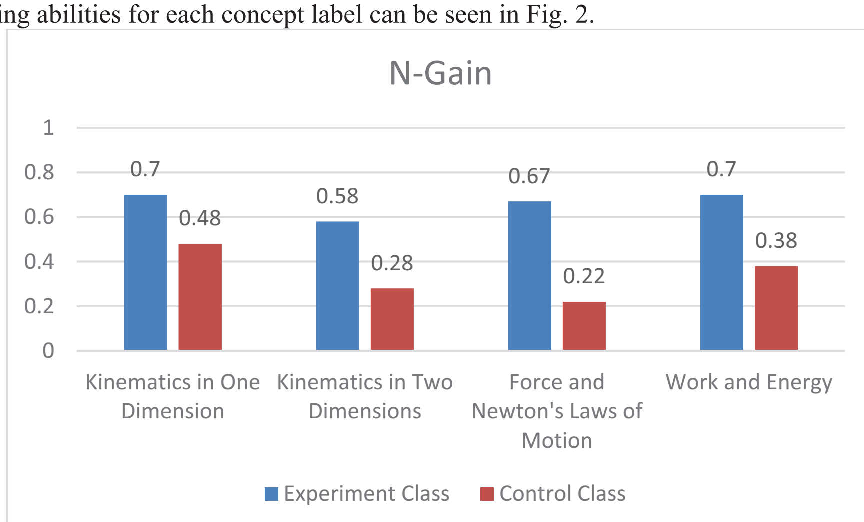

FIGURE 2. Comparison diagram of <g> capability solving each concept label of the experimental class and the control class.

Figure 2 shows that the <g> problem solving ability based on the highest concept label in the experimental class occurs on the Kinematics in One Dimension concept label in 0.7 and the Work and Energy of 0.7 both of which fall into the highest category. While the lowest on the Kinematics in Two Dimension concept label that is equal to 0.58 with the medium category. While in the control class, the highest problem solving ability occurs in the Kinematics in One Dimension concept label of 0.48 with the moderate category and the lowest is in the Force and Newton's Laws of Motion concept label of 0.28 with the low category.

In this study, the problem-solving ability developed is the problem-solving ability in a student's daily life which includes the act of solving the problem and giving the right reasons based on the concepts that have been learned. The improvement of problem solving skills is shown from the average score of the experimental class and the control class of 0.65 and 0.35, respectively. The average <g> experimental class is higher than the average <g> control class, and both are included in the medium category. From the parametric statistical test (t-test) at $\alpha = 0.05$, it was found that there was a significant difference between increasing the problem solving ability between the experimental class and the control class based on the t that has been counted = 9.067. This shows that the use of empirical abductive learning cycle models can further enhance students' problem solving abilities than conventional learning models. Based on the comparison of the average <g> problem solving abilities between the experimental and control classes, it shows that the application of empirical abductive learning cycle learning models is more effective in improving students' problem solving abilities than the application of conventional learning models.

The results of the analysis of the improvement of problem solving abilities based on the concept label obtained <g> the highest problem solving ability of students in the experimental class occurred on the concept label of

Kinematics in One Dimension and Work and Energy both of which were 0.7 with a higher category. To label the concepts of Work and energy, problems are given regarding the application of kinetic energy, potential energy, theorem of work - energy, conservative forces and non-conservative forces. Whereas on the label concept of Kinematics in One Dimension about creating and interpreting graphs of position, speed and acceleration of the time function of Regular Straight Motion, Straight Motion Changes Irregularly and free fall motion. These indications show that the empirical abductive learning cycle model is suitable for discussing problems involving motion events in one dimension and effort-energy. However, in general the improvement of students' problem solving skills on each concept label for the experimental class that uses empirical abductive learning cycle models is better than the control class that gets conventional model learning.

While the low increase in <g> ability to solve problems based on the concept label in the experimental class occurred in the concept of Kinematics in Two Dimensions that is equal to 0.58 with the medium category. This shows that the empirical abductive learning cycle learning model is not very suitable for solving the problem with the concept label determining the frame of reference, coordinate system, position, speed and acceleration in two dimensions, graphs and equations of Regular Circular Motion, Circular Motion Changes Irregularly, and bullet motion. The low <g> problem solving ability on motion concept labels in two dimensions is possible because the concepts are not too detailed discussed in learning.

From the results obtained, the increase in students' problem solving abilities on basic physics material using empirical abductive learning cycle models can be significantly higher than students who obtain conventional learning.

CONCLUSION

Empirical abductive learning cycle models can significantly improve students' problem solving abilities compared to conventional learning models in basic physics lectures.

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