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Effect of Physics Problem Solving on Structures Schemes and Knowledge Associations

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Abstract. This study aims to develop learners' thinking structures through associations, case based, and schematic method so that different knowledge structures have a role in influencing the structure of creative thinking. The learners have low mastery of physics materials since they are not given sufficient opportunity to build their own knowledge. They should be directed to approach each new problem or task with their prior knowledge, assimilate new information, and construct their own understanding. The design of this research was a quasi-experiment using purposive sampling. Data were analyzed using variance analysis. The design of this research was a quasi-experiment using purposive sampling. Data were analyzed using variance analysis. The learning process of problem-solving consists of: 1) identifying problems, 2) planning projects, 3) creating projects, 4) presenting projects, and 5) evaluating projects. From the results of this research, it can be concluded that problem-solving method can provide strong supports in developing the learners' creative thinking skills as they can share their knowledge and interact with their friends and the environment. This learning activity also constitutes an appropriate technique to help the learners to develop problem solving knowledge and skills.

1. Introduction

Education has an important role in determining the development and individual self-realization. It is responsible for developing talents and abilities optimally so that children can manifest themselves and fully do their roles according to personal and community needs [1]. Science learning is concerned with how to systematically find out about nature so that it is not only mastery of knowledge collection in the form of facts, concepts or principles but also process of discovery. In the 21st century, science and technology in different sorts of life aspects in society develop rapidly, especially information and communication technology. Thus, it is necessary to provide a way of learning that can prepare learners to able to think logically, critically, creatively and can argue correctly. In addition, it is also essential to develop attitudes and values including curiosity, honesty, patience, open-mind, not rational, criticality, diligence, tenacity, carefulness, discipline, caring about the environment, paying attention to work safety, and cooperate with others. Therefore, in this current global information era, all people are able to obtain a lot of information quickly and easily from various sources and different parts of the world. That's why, everyone must have the ability to acquire, select, manage, and follow up the



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information to be utilized in a dynamic life, which is full of challenge and competition as it is today. These all demand them to have the ability to think critically, creatively, logically, and systematically in facing many kinds of problems. If the learning activities do not accommodate the development of learners' abilities in problem solving, reasoning, connection, and communication. Nowadays, learners' high level cognitive abilities are very weak because learning activities are used to being done by encouraging learners only to think at a low level. Those learning activities show that it is important to find efforts to improve the quality of learning, especially in the development of high level thinking skills [2].

One of the causes of the low mastery of physical materials is that the learners are not given sufficient opportunities to build their own knowledge. Learning is no longer seen as a knowledge transfer process to be stored in a memory system through repeated practices and reinforcements. The learners should be directed to approach each new problem or task with their prior knowledge, assimilate new information, and construct their own understanding. One of the materials in the subject of physics is dynamic electricity. One is the application of electricity to the human heart. The heart is one source of electrical energy in the body of living things. The mechanism of electrical incidence in the heart is similar to electricity, where an electric current will be generated in a closed circuit that has a potential difference. The direction of electric current in the direction of positive charge motion and the amount of electric charge flowing through the conductor of each one time unit, commonly called the current strength can be written with the equation: $I = dQ / dt$. We can express this change in charge Q in terms of the change in the voltage V across the membrane capacitor C , that is, $Q = C V$. Electricity that can cause the heart beats, moving pumps blood throughout the body of living things. Inhibition of electrical flow in the heart will cause not smooth flow of blood throughout the body[3,4].

The involvement of some thinking knowledge structures raises a number of questions [5]. For examples, do some forms of knowledge provide a useful basis for the forming of creative problem-solving? Is problem solving more likely to occur if some knowledge structures are applied? And, does the use of one kind of knowledge structure facilitate or inhibit the application of other knowledge structures? Hence, the purpose of this study is to examine how different knowledge structures, especially associations, case-based, and schematic play a role in influencing the structure of thought [6,7].

1 Experimental Method

The design of this research was a quasi-experiment using purposive sampling. There were two classes, each of which consisted of 19 learners. Data were analyzed using variance analysis. The learning process of problem solving was started by giving the case problem to the learners. Both classes were given different treatments, with applying associations, case based, and schematic method and without applying the method. All learners analyzed the problems consisting of: 1) identifying problems, 2) planning projects, 3) creating projects, 4) presenting projects, and 5) evaluating projects [8]. This research was conducted from February 2017 to April 2017. The subjects of this study were the second semester students of Mechanical Engineering Department of Universitas Nusantara PGRI Kediri in Physics Engineering II.

Data on the application of learning were analyzed using inferential statistics to know the effect of learning which was developed towards the improvement of the learners' thought structure abilities through associations, case based, and schematic[9,10]. Data processing was aimed to know the difference of learners' ability through associations, case based, and schematic. Statistical testing was done through the following stages:

- 1) Normality Test
- 2) Homogeneity test
- 3) Independent Test
- 4) Analysis of the data variance of learners' ability towards associations, case based, and schematic abilities
- 5) Post hoc test of scheffe to determine the factors that affect the structure of thought

3. Result and Discussion

In the data analysis procedure, it is necessary to check first IIDN (Identical, Independent, and Normal Distribution) first. The residual normality test is performed using the Anderson-Darling Test which can be found in the minitab 16 program as shown in Figure 3.1 for normality test without using associations, case based, and schematic method.

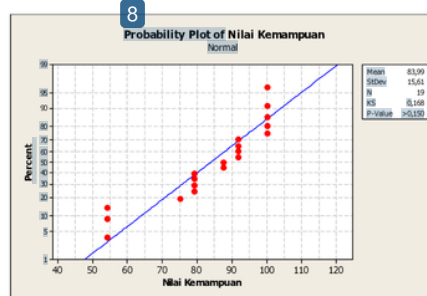


Figure 3.1. Normality test without using associations, case based, and schematic method

Figure 3.2 shows normality test using associations, case based, and schematic method.

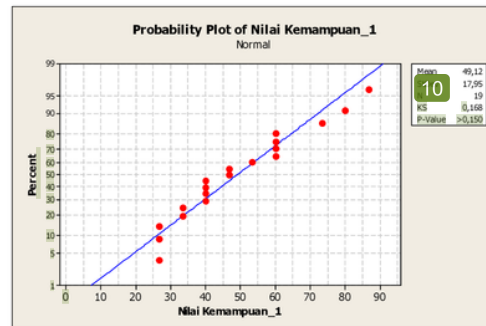


Figure 3.2. Normality test using associations, case based, and schematic method

Based on figures 3.1 and 3.2 it is seen that p-value with a value of 0.15 is greater than $\alpha = 0.05$. Hence, it can be concluded that the residual is normally distributed. After doing the normality test, it is continued to do homogeneity test to determine whether the research data generated are identical or not. Figure 3.3 below displays the result of homogeneity test.

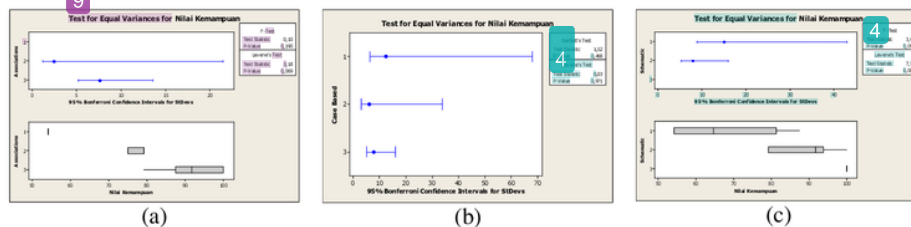


Figure 3.3. Homogeneity test (a) associations (b) case based (c) schematic

The assumption which can be drawn from Figure 3.3 is that identical residuals are fulfilled. The last test of the data is the independence of research data using auto correlation function which is in minitab 16. Figure 3.4 (a) is an independent test through associations, case based, and schematic method. The other one is Figure 3.4 (b) which displays an independent test without using associations, case based, and schematic method.

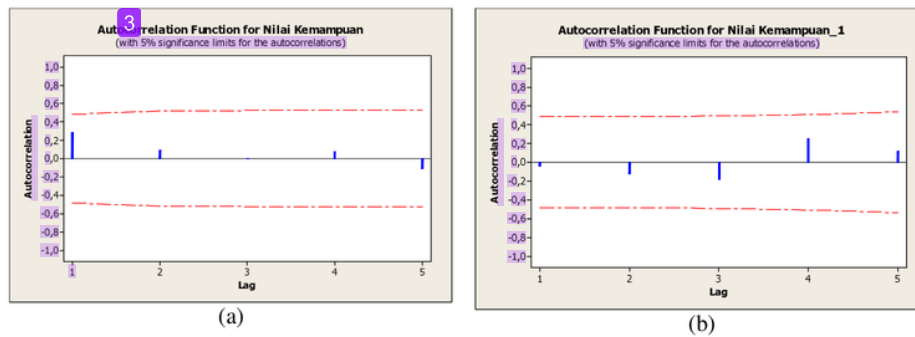


Figure 3.4. (a) Independence test using associations, case based, and schematic method
(b) Independence test without using associations, case based, and schematic method

After testing the assumption of IIDN, it is continued by analyzing the data of research results to know the relationship among associations, case based, and schematic as in table 3.1 below.

Table 3.1 The relationship among associations, case based, and schematic

Knowledge	Average Score
associations	84,21
case based	78,95
schematic	61,40
score of structure ability	83,99

The table shows that associations have a high enough score compared to case-based or schematic. These three factors are crucial to determine the structure of the learners' ability. This is because knowledge of associations is fundamental in building the structure of knowledge. Moreover, Table 3.2 illustrates knowledge structures built without associations, case based, and schematic method and Table 3.3 presents knowledge structures built with associations, case based, and schematic method.

Table 3.2 Scores of the learners' ability without using associations, case based, and schematic method

Knowledge	Average Score
identifying problems	50,88
planning projects	47,37
creating projects	49,12
presenting projects	47,37
evaluating projects	50,88
ability score	49,12

It can be seen that the learners' ability built through the learning stages of activation of association knowledge, case knowledge, and scheme in the thinking is higher than the other without implementing the learning as shown in Table 3.3

The learners' average score in to identifying problems, planning projects, creating projects, presenting projects, and evaluating projects gets higher if it is built through associations, case based, and schematic method. It proves that the structure of one's knowledge will be more developed if it is built through the stages of habit and repetition of cases and experiences that have occurred [11-13].

Table 3.3 Scores of the learners' ability using associations, case based, and schematic method

Knowledge	Average Value
identifying problems	84,21
planning projects	85,96
creating projects	85,09
presenting projects	80,70
evaluating projects	83,99
ability score	83,99

The next analysis is analysis of variance. The analysis result of minitab 16 is described in Table 3.4.

Table 3.4 Analisis of variance for aability's scores using Adjusted as for Taste

Source	DF	Seq SS	Adj MS	F	P	% Contribution
Associations	2	3683,46	485,98	242,99	0,000	84,02
Case Based	2	471,84	314,83	159,41	0,001	10,76
Schematic	2	83,41	83,41	41,71	0,066	1,90
Error	12	145,42	145,42	12,12		3,32
Total	18	4384,14				100,00

S = 34,8170 R-Sq=96,68 R-Sq(adj)=95,02%

From associations factor, it can be concluded that $F_{\text{value}} = 242.99 > F_{(0.05; 2; 18)} = 3.55$ indicates that there are influence associations on the learners' ability in building knowledge structure. Another factor is case-based. In case-based, $F_{\text{value}} = 159.41 > F_{(0.05; 2; 18)} = 3.55$ shows that there is a case-based influence on the learners' ability in building knowledge structure. The last factor is schematic. The conclusion which can be drawn based on $F_{\text{value}} = 41.71 > F_{(0.05, 2, 18)} = 3.55$ is that there is an influence of schematic towards the learners' ability in building knowledge structure. The test, then, is continued by using scheffe method to compare the research result data. This test is performed to determine the contrast of each research factor.

$$1 = 1 \quad 2 \quad \textcircled{R} \quad |C_1| = \bar{y}_1 - \bar{y}_2 = 2,52631 \quad 2,36842 = 0,15789$$

$$2 = 1 \quad 3 \quad \textcircled{R} \quad |C_2| = \bar{y}_1 - \bar{y}_3 = 2,52631 \quad 1,84210 = 0,6842$$

$$3 = 2 \quad 3 \quad \textcircled{R} \quad |C_3| = \bar{y}_2 - \bar{y}_3 = 2,36842 \quad 1,84210 = 0,52632$$

The result of the test depicts that the comparison of associations with schematic has considerable contrast. This shows that associations have very important roles in building the learners' knowledge structures. Based on Table 3.4, associations reach the highest value, 84.02% if it is compared to other factors. Therefore, activation of association factors in learning is very important in determining the learners' knowledge structure [14,15].

4. Conclusion

The result of this research shows that ability of associations holds very important role in building the learners' knowledge structure besides case based and schematic. Implementing this learning method is expected to be able to contribute in identifying the learners' knowledge structure so that the learners' ability in analyzing the problems can be improved.

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