Research Paper

Increasing Critical Thinking and Student Retention: A Learning Model Approach

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ABSTRACT

The purpose of this research is to compare the effectiveness of Direct Instruction (DI) learning models assisted by multimedia and Problem Based Learning (PBL) models to increase student critical thinking skills and retention in mathematics subject based on student cognitive styles on senior high schools. The cognitive styles consist of Field Dependent (FD) and Field Independent (FI). This research used quasi-experimental type. The experimental design is non-equivalent control group with 2x2 factorial designs. The research samples in three different schools to get more accurate research data because its schools has different characteristics. Each schools has two sample classes with of 102 student of control class with DI assisted by multimedia learning model and 97 students of experiment class with PBL model. This research used test and questionnaires method to collect the research data. The research finding are that there is significantly difference of student critical thinking skills and retention between groups of student with DI learning model and PBL model and also there is significantly difference of student critical thinking skills and retention between groups of student FD and FI cognitive styles. The other finding of this research that student with FI cognitive style in Problem Based Learning has the highest critical thinking skills and retention. This research contributes to educator to find out better learning models approach for mathematics subject in senior high schools students, the interaction between student retention and cognitive styles where level of ability to remembering previous lesson influences how far students think critically.

Keywords: learning model, critical thinking skills, student retention, cognitive styles

INTRODUCTION

Critical thinking skills need to be sought early through education, so students can practice critical thinking skills in solving various problems. Students' ability to carry out analysis, synthesis, and evaluation activities logically, critically, creatively, and productively is a high-level thinking skill that students must have in making rational and responsible decisions. Therefore, students need to equip themselves with higher-order thinking skills. One part of higher-order thinking skills is the ability to think critically (Johnson, 2002).

In fact, learning process in senior high schools is not enough to improve student critical thinking skills. This is caused by the learning process still conventional learning, learning interaction is still dominated by educators than students, teaching and learning activities hold on to books only and do not provide opportunities for students to learn through interacting with concrete objects in real conditions. Another factor is the low activity of students, low student feedback on teachers, and less interesting learning media.

The effort to develop critical thinking skills can be started by implementing effective learning. One learning model that can improve critical thinking skills than conventional learning model is Problem Based Learning model (Happy & Widjajanti, 2014). The other model is Direct Instruction model where appropriate to explain the basic concept of mathematics directly to student with step by step explanations (Slavin, 2011).

Learning media can support students in learning activities, especially media that can optimize all human senses. Learning experience of person's is 75% obtained from the sense of sight, 13% of the sense of hearing and 12% of the other senses (Dale, 1969). Therefore, it is important to combine various sensory functions in a media, which is commonly called multimedia. According to (Suyanto, 2003), multimedia is the uses of computers to create and combine moving images, audio, graphics and texts by combining links and tools to navigate, interact, create, and communicate. In mathematics learning by multimedia tools has an effect of 85% on student outcomes (Pradana, 2015). Another benefit of the media is clarifying the message so that it is not too verbally, overcoming space limitations and passivity in the classroom (Barokati, 2013).

Another thing that strengthens or weakens the success of learning process, there are the cognitive styles and student retention. Cognitive styles is different with cognitive behavior, thinking behavior, and memory behavior that will affect individual behavior and activities both directly and indirectly (Lebar & Mansor, n.d.). Retention is the ability to capture information, accept it as part of thinking process, take the information and get it back when the information is needed. Retention of each student is different, including depending on the application of the learning model. Based on these learning problems, a study is needed to compare the effectiveness of learning media to develop student critical thinking skills and retention in mathematics learning by the application of Problem Based Learning model and Direct Instruction learning model assisted by multimedia for students who have different cognitive styles.

LITERATURE REVIEW

The role of educators greatly influences the learning process if educators are able to understand the characteristics of their students. The ability to identify various types of individual characters is very important in this process. Because each subjects has its own uniqueness depending on the character. So that it will have implications for the selection of learning styles and choosing strategies, models and learning methods that are considered to be effective. The learning model is the activity of the educators in the teaching and learning process that can provide convenience to students. In learning activities, the educator does not have to be fixated on one learning model, but can use other learning models that are not boring for student, more interesting and impressive.

Problem Based Learning (PBL) Model

Characteristics of problem based learning focus on problem solving activities, responsibility for solving existing problems, and the role of an educators in supporting the process when students solve problems (Eggen & Kauchak, 2012). The steps in problem solving according to (Fatimah, 2012), in the problem based learning models consisting of 1) identify the problems, 2) data collection, 3) data analysis, 4) solve the problems based on existing data and analysis, 5) choose the way to solve problem, 6) plan the implementation of problem solving, 7) conduct a trial of the plan set, 8) take action to solve problems. The first step to the fourth step is absolutely necessary in various categories of thinking level, while the fifth to the eighth step must be achieved if learning is intended to high level thinking skills.

Direct Instruction (DI) Learning Model

The direct instruction model is a learning model that gives student the opportunity to learn by observing selectively, remembering and imitating what the educators model (Eggen & Kauchak, 2012). Direct Instruction models prioritize a declarative approach with emphasis on the process of learning concept and motor skills, thus creating more structured learning atmosphere. (Slavin, 2011) proposes seven steps of syntax in direct instruction learning : 1) inform learning subjective and lesson orientation to students, 2) reviewing prerequisite knowledge and skills, 3) provide subject matter and present information, 4) carry out guidance, 5) provide opportunities for students to practice, 6) assess student performance and provide feedback, and 7) provide independent training.

Cognitive Style

Cognitive learning methods will make it easier and encourage students to learn in a predetermined situation (Djahiri, 2001). Because this is closely related to student characteristics that can affect learning activities, including : 1) cognitive style, 2) scope of interest, 3) age of terminology, 4) intelligence, 5) social-economic, 6) culture, 7) background of knowledge, 8) attitude, 9) learning achievement, 10) motivation and others (Sardiman, 2006).

According to (Nasution, 2008), people who have field dependent styles are: 1) very influenced by the environment and many depend on childhood education, 2) educated to always pay attention to others, 3) remember in the social context, 4) speaking slowly so that it is easily understood by others, 5) having extensive social relations, 6) more suitable to choose clinical psychology, 7). do not like mathematics, prefer to humanity 8) tend to like discussion, 9) need more instructions to understand something, 10) more sensitive to criticism and need to get motivation.

According to (Nasution, 2008), people who have field independent styles are: 1) the environment and past experience do not become a factor, 2) the concentration of education to foster self-autonomy in order to be independent, 3) ignoring the rules of others, 4) speak fast regardless of the other person's capture power, 5) social relations tend to be weak, 6) it is more suitable to have experimental psychology, 7) appreciate humanity and social sciences even though they are more inclined to mathematics and science, 8) prefer lectures, 9). does not require detailed instructions, (10) open to constructive criticism.

Critical Thinking Skills

Critical thinking ability is one of the abilities that is needed in solving problems. There are characteristics that can be observed to find out how much a person's ability to think critically. The characteristics of critical thinking according to (Wijaya, 2010) : 1) get to know in detail the parts of the whole, 2) smart to detect the problems, 3) able to distinguish relevant ideas from irrelevant ones, 4) able to distinguish between facts, diction and opinion, 5) able to identify information differences, 6) able to distinguish logical and illogical arguments, 7) able to develop data assessment standards, 8) like collecting data for factual verification, 9) able to distinguish between constructive and destructive criticism, 10) able to identify multiple perspectives, 11) able to test assumptions with clarity, 12) able to study ideas that conflict with events in the environment, 13) able to identify human attributes, places and objects, 14) able to register all possible consequences or alternative solutions to problems, ideas, and situations, 15) able to make consecutive relationships between one problem and another, 16) able to draw generalized conclusions from available data with data from the field, 17) able to describe conclusions carefully from available data, 18) able to make predictions from available information, 19) able to distinguish wrong

and right conclusions from information received, 20) able to draw conclusions from existing data.

Student Retention

According to (Atkinson, Atkinson, & Hilgard, 1991), the memory process experienced by a person consists of three stages : 1) Encoding, 2) storage and 3) retrieval. To be able to solve a new problem, past experience plays an important role, therefore someone who has the power of response and good memory will more easily solve problem. According to (Davidoff, 1991), testing of the ability to remember through two basic methods, including:1) the test repeated again, 2) test to recognize again. According to (Bimo, 1993), to measure one's retention ability can be done by 1) reconstruction method which the subject was asked to reconstruct the material given previously, after that the results were assessed based on the time that had been used, the mistakes made up to certain criteria, 2) pairing association method which an individuals are asked to study pairs of material. For the evaluation process, one part of the pair is used as a question and the subject is asked to recite the other pairs.

MATERIALS & METHODS

This research used quasi-experimental type. The experimental design is non-equivalent control group with 2x2 factorial design showed in table 1. The research samples in three different schools to get more accurate research data because it's schools has different characteristics. There are SMAN 1 Kedamean Gresik, SMAN 1 Wringinanom Gresik, and SMAN 1 Driyorejo Gresik. Each schools has two sample classes with of 102 student of control class with Direct Instruction learning model assisted by multimedia and 97 students of experiment class with Problem Based Learning model.

Table1. Research design 2x2 factorial

Moderate Variable	Independent Variable	Learning Model	
		Problem Based Learning Model	Multimedia-Assisted Direct Instruction Learning Model
Cognitive Style	Field Dependent (FD)	$Y_{111}, Y_{112}, Y_{113}, ..., Y_{11n}$	$Y_{121}, Y_{122}, Y_{123}, ..., Y_{12n}$
	Field Independent (FI)	$Y_{211}, Y_{212}, Y_{213}, ..., Y_{21n}$	$Y_{221}, Y_{222}, Y_{223}, ..., Y_{22n}$

This research used test and questionnaires method to collect the research data. The test consisted initial test and final test both student critical thinking skills and retention. While questionnaire used to student categorization relating to the cognitive style of Field Dependent or Field Independent. The student has a Field Dependent style if student's questionnaire score is smaller than 9 and the student has a Field Independent style if student's questionnaire score is greater than 9. The instrument has validated by expert and calculated the degree of validity and reliability. In general, the results of the validation by the experts stated that the instrument was in accordance with the learning objectives, the instrument had covered all aspects of the assessment, but the order of indicators in learning needed to be adjusted. After conforming to the learning objectives and the assessment aspects, the instrument is considered to have fulfilled the requirements as a valid measuring instrument. Based on validity degree of instrument by SPSS 23, all items have total correlation value greater than r table. To analyze the research data, a descriptive analysis and factorial Multivariate Analysis of Covariance (MANCOVA) were used. The covariate of the research data is the initial test score of student critical thinking. All of the statistical analysis processes in this research used SPSS 23.

RESULT

Data collection activities began with categorizing the cognitive styles of students

in the experimental and control group. The result of student cognitive styles identification is showed in table2 below. The result of the identification showed that the cognitive style of Field Dependent dominated more than the Field Independent in the control group, in other side, the cognitive style Field Independent was more dominant that Field Dependent in the experimental group.

Table2. Students Cognitive Styles Classifications

Cognitive Style	Control Group (*Direct Instruction* (DI))	Experiment Group (*Problem Based Learning (PBL)*)	Total
Field Dependent (FD)	59	48	107
Field Independent (FI)	43	49	92
Total	102	97	199

After classified students cognitive styles, the next step is initial test of critical thinking skills. The result of the initial test of critical thinking skills is showed in table3 below. Overall, the result of the initial test did not shown any differences in the critical thinking skills of mathematics between students who had the field dependent and the field independent cognitive styles, both in the control and experimental group. This also provides an illustration, that the initial ability of the research subjects there is not significantly different.

The initial ability of the research subject originating from the results of the initial test was analyzed by SPSS 23 program to get an idea of the significance value of mathematical critical thinking skills between the control and experimental group. The result of the unpaired t-test (independent sample t-test) presented in table4 below.

Table4. Independent Sample t-Test of Learning Models for Initial Test

Learning Model	n	Mean	std. dev.	t	sig. (2-tailed)
Control Group (*Direct Instruction (DI)*)	102	53.85	16.11	-0.877	0.382
Experiment Group (*Problem Based Learning (PBL)*)	97	55.87	16.41		

Based on significant values in table4 of $0.382 > 0.05$, it means that there is no significant difference in the value of critical thinking skills in initial test between control and experiment group. In other words, before giving treatment to both groups of students using Problem Based Learning model and multimedia assisted Direct Instruction learning model, the critical thinking skills of mathematics in the two groups was not significantly different. After the t-test on the control and experimental groups, the t-test was also given on cognitive styles aspect is showed in table5 below.

Table5. Independent Sample t-Test of Cognitive Style for Initial Test

Cognitive Styles	n	Mean	std. dev.	t	sig. (2-tailed)
Field Dependent (FD)	107	52.76	15.54	-1.953	0.052
Field Independent (FI)	92	57.24	16.80		

Based on significant values in table5 of $0.052 > 0.05$, it means that there is no significant difference in the value of critical thinking skills in initial test between Field Dependent and Field Independent students. In other words, before giving treatment to both groups of Field Dependent and Field Independent students, the critical thinking skills of mathematics in the two groups was not significantly different.

The treatment was carried out in five meeting with 2x45 minutes respectively. The activity was followed by giving the final test and after two weeks each group was given retention test to find out how much ability still survived in the cognitive structure of the students. The final test results of critical thinking skills and student retention based on cognitive styles showed in table6 below.

Table6. Comparison of Critical Thinking Skills

Cognitive Styles	Control Group			Experiment Group		
	(*Direct Instruction* (DI))			(*Problem Based Learning* (PBL))		
	Mean		N-Gain (%)	Mean		N-Gain (%)
	Initial test	Final test		Initial test	Final test	
Field Dependent (FD)	55.36	72.66	52	49.58	79.58	60
Field Independent (FI)	51.78	82.71		62.04	84.97	

In the table6, the mean student initial test of critical thinking skills with Direct Instruction learning model assisted by multimedia of 55.36 for Field Dependent and 51.78 for Field Independent cognitive styles while the final test 72.66 for Field Dependent and 82.71 for Field Independent cognitive styles. The mean student initial test of critical thinking skills with Problem Based Learning model of 49.58 for Field Dependent and 62.04 for Field Independent cognitive styles while the final test 79.58 for Field Dependent and 84.97 for Field Independent cognitive styles. Based on the percentage of N-Gain value, Problem Based Learning model has 60% and Direct Instruction model assisted by multimedia has 52 %.

Table7. Comparison of Student Retention

Cognitive Styles	Control Group		Experiment Group	
	(*Direct Instruction* (DI))		(*Problem Based Learning* (PBL))	
	Student Retention		Student Retention	
	Mean	Std. dev.	Mean	Std. dev.
Field Dependent (FD)	65.37	5.67	71.59	5.87
Field Independent (FI)	74.81	7.03	79.32	5.48

In table7 showed the mean student retention with Direct Instruction model assisted by multimedia in Field Dependent cognitive style of 65.37 while in Field Independent cognitive style of 74.81. The mean student retention with Problem Based Learning model in Field Dependent cognitive style of 71.59 while in Field Independent cognitive style of 79.32.

Assumptions that must be met before the MANCOVA factorial test are: a). samples must be taken randomly, b). data are normally distributed (normality test), and c). homogeneous variance between groups (variant homogeneity test). MANCOVA output basically has two parts, namely the output whether there are real differences between groups and the output that tests each variable individually. The SPSS program calculation results with the MANCOVA analysis technique that tests each variable individually at a significance value of 0.05 are presented in the following table8.

Table8. Tests of Between-Subjects Effects Multivariate Analysis of Covariance

Independent Variable	Dependent Variable	F	Sig.	Explanation
Critical Thinking	Critical Thinking (final test)	5.922	0.016	Significant
	Student Retention	5.790	0.017	Significant
Learning Model	Critical Thinking (final test)	36.174	0.000	Significant
	Student Retention	42.418	0.000	Significant
Cognitive Style	Critical Thinking (final test)	101.967	0.000	Significant
	Student Retention	108.004	0.000	Significant
Learning Model * Cognitive Style	Critical Thinking (final test)	5.153	0.024	Significant
	Student Retention	0.149	0.700	Not Significant

DISCUSSION

From the result above, it is known the mean final test of critical thinking value of students with Problem Based Learning model (both FD and FI) higher than the mean final test of critical thinking value of student with Direct Instruction learning model assisted by multimedia (both FD and FI). According to (Hake, 1999) categorizes the interpretation of N-gain effectiveness as follows: if the percentage value of N gain <40 is not effective, 40-55 is less effective, 56-75 is quite effective and >75 is effective. It is known that the control group N-Gain value is 52% including the less effective category while the experimental

group N-Gain value is 60% including the quite effective category. In addition, the mean final test of critical thinking value of students with Problem Based Learning model (both FD and FI) >75. This is supported by previous research by (Baroh, 2010), that the learning model is said to be effective in improving student critical thinking, if the student critical thinking score more than 75 from maximum score of 100. Therefore, Problem Based Learning model more effective than Direct Instruction learning model assisted by multimedia to improve student critical thinking skills.

Furthermore, the mean of student retention with Problem Based Learning model (both FD and FI) higher than the mean of student retention with Direct Instruction model assisted by multimedia (both FD and FI). According to (Setiawan & Indrawati, 2012), categorizes the interpretation of student retention as follows: if the percentage value of student retention $R \leq 60\%$ is low categories, $60\% < R < 70\%$ is medium categories and $R \geq 70\%$ is high categories. It is known that student retention with Problem Based Learning model (both FD and FI) has high categories and student retention with Direct Instruction model assisted by multimedia has medium categories in Field Dependent cognitive style and high categories in Field Independent cognitive style. It can be concluded that Problem Based Learning model better than Direct Instruction learning model assisted by multimedia in student retention.

The results of testing independent and dependent variables (test of between-subjects effects MANCOVA). There is a significant difference if the significance value is less than 0.05 (P-value < 0.05), while the difference is not significant if the significance value is greater than 0.05 (P-value > 0.05). In the table8 showed a significant difference between the learning model of Problem Based Learning and Direct Instruction models assisted by multimedia for critical thinking skills with F value of 36.174 with a significance level of

0.000 and student retention with F value of 42.418 with a significance level 0.000. The cognitive styles showed a significant difference between the Field Dependent and the Field Independent for student critical thinking with F value of 101.967 with a significance level of 0.000 and for student retention with F value of 108.004 with a significance level of 0.000. As for the interaction between learning model and cognitive style only showed a significant difference for mathematics critical thinking skills with F value of 5.153 with a significance level of 0.024, while for students retention mathematics learning showed no significant difference, because has F value of 0.149 with a significance level of 0.700.

CONCLUSION

There is a significant difference from the learning model of Problem Based Learning and Direct Instruction on critical thinking skills and students retention of mathematics learning. There is a significant difference of the cognitive styles Field Dependent and Field Independent to critical thinking skills and students retention of learning mathematics. There is a significant differences interaction between learning models (PBL and DI) and cognitive style (FD and FI) on student critical thinking skills, while on student retention there is no significant difference interaction between learning models (PBL and DI) and cognitive style (FD and FI).

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