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Metacognition Ability of Students in the Learning of Control Variable Strategy Assisted with Scientific Teaching Materials

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Abstract

Strategy Variable Control (CVS) with scientific teaching material is expected to be able to prepare students to face the challenges of the 21st century, especially in mastering metacognition abilities. This study has purpose to analyze the influence of CVS with scientific teaching materials on metacognition abilities of learners. It was done in grade VII SMP PGRI 1 Ajibarang in the first semester of the academic year of 2019/2020. The sampling technique in this study was purposive sampling. The method used in this study was quantitative method with quasy experimental design using control group design. The data in this study was metacognition abilities collected through questionnaires and observation sheets. The data of metacognition ability were analyzed using regression, coefficient of determination, *N-Gain Test,* and *T-Test*. The test results and the regression coefficient of determination showed a significance value of 0.000 > 0.05, therefore, CVS with scientific teaching material has significant effect on the ability of metacognition 83.6%. The *N-Gain* Test Results indicated the level of increase in the ability of metacognition in the experimental group which is higher than the control group. The results of *T-test* showed a significance value of 0.00 0> 0.05, therefore, there is a difference in the average score of the experimental group and the control group. Based on the results of this study, it can be concluded that CVS with scientific teaching material has a significant effect on the ability of metacognition.

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INTRODUCTION

Entering the 21st century in science a lot of reforms and innovation particularly in skills and competencies, it is important for the millennial society with evolving knowledge needs (Zahid, 2015). Their knowledge comes from a series of knowledge generation process that is one of the skills of the 21st century (National Research Council, 2010). The generation process sains can be obtained from formal education through science lessons at school.

Learning science as an appropriate means to develop a 'way of knowing' means the tendency of attitude/ action, curiosity, thinking habit, and the procedure for doing something (Carin & Sund, 1985 in Maysyarah, *et al.,* 2018), The habit of thinking form a pattern of thinking that leads to the metacognition ability of learners. Metacognition ability consists of the ability to plan, monitor and evaluate the learning process of each individual (A Nort Central Regional Educational Laboratory, 1995 in Lynch & Knight, 2011).

Based on the observation conducted to learners in SMP PGRI 1 Ajibarang Banyumas, researcher found some problems in the science learning, in the practicum conducted in the science teaching of the 7th grade that running unfavorable where in each group practicum, not all learners were doing a good job, just 3 of 7 children per group working in groups due to less effective learning resources. This happens since students do not prepare practicum well, for example, a few learners do not carry tools and materials prepared for learners do not understand in understanding the information provided (planning), experiments were done by some learners do not do well, the participants students less focused, they do not do lab work in accordance with the procedure (monitoring) and after the completion of some learners are not able to conclude what is being done (evaluation). Considering some problems that are categorized into the components of metacognition abilities, it can be concluded that the learners of SMP PGRI 1 Ajibarang have a low metacognition abilities.

The low metacognition of learners can be influenced by either internal factors or external factors as stated by Alkadrie & Mirza (2015). One of the internal factors that has affect is the memory storage of learners. Memory storage in order to be a long-term memory can be done with the coding and repetition. Some kinds of information stored in long term memory such as encoding on declarative and procedural memory (Croocks & Stein, 1991 in Isnaeni & Khumaedi, 2015). Factual information obtained from the investigation to solve the problem so as to obtain a valid fact (Bower, 1975 in Bhinnety, 2008).

The problem solving process requires a hypothesis. The hypothesis can be found in the teaching of science through experiments done by learners (Klahr & Nigam, 2004). At the time of testing hypotheses through experimentation, learners need to be given stock of experience on how to design and do experiments. Teach students to be able to design and do experiments can be carried out in the learning process by using Variable Control Strategy (CVS) (Lazonder & Egberink, 2014). US Department of Education, Institute of Education Sciences (2012) examines the CVS is defined as a method to teach students how to design and do experiments that are controlled so that they obtain a valid experimental results and interpretations are easy to understand.

Schalk, *et al.,* (2019) states that CVS application causes the students understanding of the content of learning materials better, and this is when learners are given the problems actually own initial perception of the existing problems. Furthermore, the students were directed to conduct experiments to investigate how some of the variables that affect the possibility of these problems. In a fact-finding activity learners perform activities comparing the variables studied. In addition, learners communicate with other learners and teachers related to the experimental results obtained. CVS include scientific activities that encourage learners to seek out information from various sources, including the investigation that is included in the curriculum implementation in 2013.

Permendikbud No. 81A in 2013 mandated the teaching strategy that involves scientific approach, how learners to achieve these outcomes. Graduate Competency Standards Compliance Content Standards and the principle of learning is to enable learners (Permendikbud No. 22 of 2016). Enabling learners can do in

learning to use CVS (Schalk, *et al.,* 2019). Therefore, CVS is necessary as a learning strategy that enables learners to active in the process of learning.

Experimental activities learners need guidance in the form of a worksheet or LKPD learners. LKPD a means to assist and facilitate the teaching and learning activities so as to form an effective interaction between teachers and learners, to increase generic science skills (Diba, *et al.,* 2017), activities and achievements of learners (Umbaryati, 2016). In addition, learners require instructional materials to analyze the results of experiments in order to obtain a conclusion or answer to a problem experiment. So the experiment in learning activities to be more ideal to be applied in the presence of LKPD and teaching materials are fused as a source of learning. Learning resources used in SMP PGRI 1 Ajibarang still in the form of printed books from the library that are less efficient in its use. Learners lazy to read for learning resources between LKPD and teaching materials are still separate. So as to overcome these problems need to develop LKPD and teaching materials as a guide for conducting experiments in science teaching.

Based on the above reasons, the CVS with scientific teaching materials applied to students in order that to find its effect on the ability of metacognitive of learners in grade VII SMP PGRI 1 Ajibarang, Banyumas regency in the energy materials of science learning.

METHODS

The research method in this study was a quantitative method with quasy experimental study with control group design. (Sugiyono, 2012)

The population of this study was grade VII SMP PGRI 1 Ajibarang, Banyumas. A sampling technique used was a nonprobability sampling techniques of purposive sampling. The sample in this study was two classes that have an average of low metacognition abilities. One class used as the experimental group, meanwhile, another class as the control group.

Variable independent of the study include: CVS with scientific teaching materials, whereas, the dependent variable: metacognition abilities of learners.

Learning instrument that will be used, it must first be tested for validity (construct validity, content validity, and validity of the items). The data collection techniques used in this study was based on the variables studied such as: a questionnaire was used to obtain data on the metacognition abilities of learners and observation used to observe the implementation of the CVS with scientific teaching materials. The effect test, the increase in the average score of the questionnaire pre intervention and post intervention, as well as the difference in the average of the experimental and control groups were tested using a simple regression test, the coefficient of determination, Normality Gain Test (N-Gain Test), and Independent Simple T Test (T-Test).

RESULTS AND DISCUSSION

The results of the data analysis of metacognition abilities of learners includes data normality tests, homogeneity tests, and a linearity test the 2019/2020 academic year.

Metacognition abilities normality test results obtained the Sig. 0.200 > 0.05 indicates that the samples are normally distributed.

Results of homogeneity test metacognition abilities obtained the Sig. 0.542 > 0.05 indicates that the sample includes a homogenous group.

Linearity test results obtained the Sig of metacognition abilities. 0965> 0.05 indicates that there is a significant linear relationship between CVS made the scientific teaching of the ability of metacognition.

Data on the ability of metacognition obtained from non-test methods in the form of a questionnaire before the intervention and after intervention questionnaire. Indicators questionnaire developed by Schraw & Dennison (1994), Cooper *et al.,* (2008), and Lee *et al.,* (2009).

Simple regression test results on the ability of metacognition can be seen in Table 1.

Table 1. Simple Regression Test Results

Model	B	Std. Error	Beta	T	Sig.
CVS aided scientific teaching materials	2.587	0.220	0.915	11.747	0.000

Simple regression test results obtained by the value of Sig. The result of the Sig value was 0.000> 0.05, indicates that CVS with scientific teaching material has effect on the ability of metacognition.

The test results of coefficient determination obtained R Square is 0,836 or 83.6%. This means that CVS with scientific teaching materials in the experimental class give effect at 83.6% on metacognitive ability of learners.

Test results of the N-Gain on metacognition abilities can be seen in the following Table 2.

Table 2. Results of N-Gain Test

Scores N-Gain	Experiment	Control
Average	41.10	33.82
Minimal	17.54	8.00
Maximal	79.49	77.78

N- Gain Test Results obtained an average score of metacognitive ability of experimental classes with a value of 41.10, whereas, the control class with a value of 33.82. This means that the effectiveness of the learning by CVS with scientific teaching materials in the experimental class is in the moderate category, whereas, the control class with conventional learning is not effective.

The results of T-test on metacognition abilities can be seen in Table 3 as follow.

Table 3. Results of T-Test

		t-test for Equality of Means		
		T	df	Sig (2-tailed)
Metacognition ability	Equal variance assumed	4.261	56	0.000

Result of T-Test obtained the Sig. 2-tailed 0.000 <0.05, indicated that there is a difference between the average ability of metacognition in the experimental group and the control group.

Based on research that has been done on the control class obtained an average score of metacognitive ability classes pre-post intervention has increased from 50 to 58 while the experimental group of 51 to 70. Based on Figure 1, it can be seen that both the control and experimental showed an increase in the metacognition ability, however, the second group had an average difference. The average data of metacognitive abilities using statement item based fusty metacognition ability in the control class and the experimental class is presented in Figure 1.

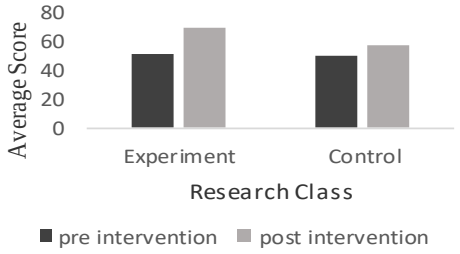

Figure 1. The Average Score of Metacognition Ability Pre and Post Intervention

The average score of the questionnaire pre-post intervention in the control group and the experimental group based on indicators of the ability of metacognition in a row presented in Figure 2 and Figure 3.

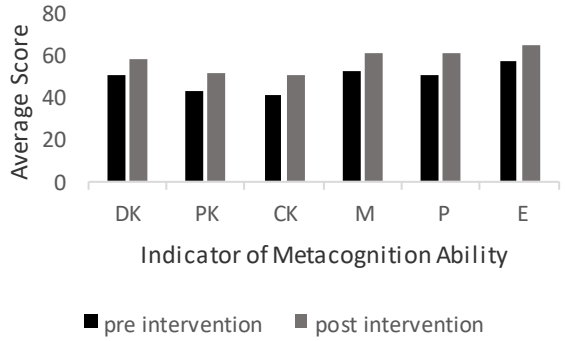

Figure 2. Average Score Metacognition Ability Class Before-After Control Interventions

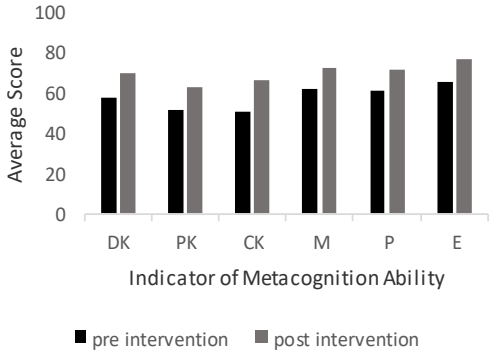

Figure 3. The Average Score of Metacognition Ability of Experimental Class Pre-Post Intervention

Metacognition ability learners after receiving CVS based learning with scientific teaching material can be seen from the results the average score of metacognition abilities pre and post intervention in Figure 2 that compares the average acquisition value of the experimental class and control class. The test results demonstrate the applicability of CVS made scientific teaching in the experimental class was increased while the control class with conventional learning also increasing but the level of increase was low. It is in line with the N-Test Gain in Table 2. Based on this data, it can be concluded the learning of CVS with scientific teaching material has effect on metacognition abilities of learners.

The ability of metacognition is used based on the theory of self-assessment questionnaire Metacognitive Awareness Inventory (MAI) developed olehSchraw & Dennison (1994), Cooper *et al.,* (2008), and Lee *et al.,* (2009) which consists of six indicators of the ability of metacognition;

(1) declarative knowledge (DK);
(2) The procedural knowledge (PK);
(3) The conditional knowledge (CK);
(4) monitoring the understanding (M);
(5) planning (P); and
(6) evaluation (E). The data can be seen in Figure 5.

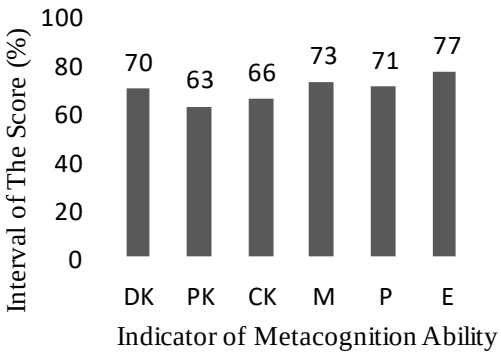

Figure 5. Graph of Metacognition Ability Post Intervention

Based on Figure 5, it can be seen that each learner obtain an average score above 60 per indicator, therefore, it can be concluded that the students answer the self-assessment questionnaire metacognitive ability per indicator with the conclusion DK (good); PK (good); CK (good); M (good); P (good); and E (excellent) in the learning of CVS with scientific teaching material. The highest mean score 6 contained in the evaluation indicators. The data are presented in Table 8 as follow.

Table 8. Scores Based on Each Indicator Statement

Indicator	Statement	Mean Score
1	1. 6	4.31
2	11	4.10
3	17	4.03
4	22	4.41
5	26	4.34
6	35	4.45

Based on Table 8 statement numbers 1, 6, 11, 17, 22, 26, and 35 is the highest expression with the average score over each indicator compared to other statements. As for the statement that is; statement number 1, "I know the important information that can be used in solving the problem"; statement number 6, "I studied harder when I liked a topic"; statement number 11, "I am confused to choose the right strategy for me to use when I learned"; statement number 17, "I am less able to motivate myself to learn when I need it"; statement number 22, "I'm trying to learn more about the concepts that I can apply to solve the problem"; statement number 26, "I still solve the problem though difficult, if I ask a friend then

I will remember the steps of its solution "; and statement number 35, "After I solve the problem, I ask myself whether there is a simple way to solve the problem".

The above data shows that out of the six indicators, indicator 6 obtain data on the highest score in the evaluation related mainly to solve the problem. This shows that the learning of CVS with scientific teaching has a good effect on students in stimulating problem solving skills (Romli, 2012).

Research related to CVS with scientific teaching materials was carried out in three meetings. The themes applied in each meeting session include making lime voltaic cells, photosynthesis and respiration. Every meeting presentation of learning was identical to the application of the strategy. Therefore, researchers presented the study as follows; (1) CVS-based scientific teaching is a collaboration between the implementation strategy and resource control variables scientific approach. CVS has a function as a guide experimental steps in learning for teachers in the classroom, and for students when doing experiments. An approach of scientific teaching materials used source of reading and LKPD developed and adapted to the scientific approach. Scientific approach teaching materials facilitate learners in the use of learning resources; (2) The application of scientific teaching material CVS requires facilities adequate tools and materials. If not met would hinder the learning process by using CVS; (3) Students in groups can determine the independent variables used in experimenting. The independent variable chosen is used to conduct the comparison activity so that conclusions can be easily understood. This shows that students respond positively to these activities (Putra, *et al.,* 2018).

Results were in line with the opinions and relevant research conducted by Schalk, *et al*., (2019); D. Mayer, Sodian, Koerber, and Schwippert (2014); National Research Council (2012); Schunk & Zimmerman (2007), which states that the CVS test is required to understand causal hypotheses; designing an experiment that is conclusive and valid; and learners are critical to evaluate the experimental results. Indirectly teachers hone the skills of metacognition through the implementation of CVS. This is in accordance with the results of research Fitriana, *et al.,* (2016) which states that direct learning using experiments can improve the ability of metacognition. Application of CVS integrated with scientific approach, it is done to meet the demands of the curriculum in 2013 in Indonesia. CVS is applied to the three phases which include, exploratory phase, a training phase and the assessment phase (Chen & Klahr, 1999). While the scientific approach includes five stages which include observing, ask, information collection, assisiation dan communication (Supriyadi, 2017). The scientific approach as a frame of reference in making teaching materials. These teaching materials can improve the ability of metacognition, the ability to reason (Nurhidayati *et al.,* 2017), the ability of mathematical representation (Ramziah, 2016), scientific literacy (Kurnia, *et al.,* 2014) and the ability to think at a higher level (Yuliati, 2013) .

In the exploration and observation the stage, learners were faced with the need information to be used in solving the problem. Statement questionnaire includes declarative knowledge, knowing the information, selecting information, pay attention to the relationship hypothesis, understand the information, and interest in the problems encountered. The questionnaire statement is presented in Figure 5 on the DK indicator with a score of 70% which is categorized as good. According to Winkel (2004) declarative capabilities include knowledge about the data that is factual. This ability is related to recall some information relating to the facts and data as well. The capability refers to the ability of self monitoring of the understanding (Ulfa, 2009). The weakness of this ability can make it difficult to understand the meaning of the material.

Declarative ability is closely related to metamemory ability. This capability refers to the awareness and knowledge of learners tentangsistem memory and strategy for the effective use of memory (Tsalas *et al.,* 2017). One strategy that can be used in converting short term memory into long-term memory that CVS by using the model instruction Guided Inquiry (Schalk, *et al.,* 2019). However, to realize the implementation of the curriculum in 2013, this study uses the integrated CVS uses scientific approach teaching materials which can improve

the ability of metacognition. According to Taqqiyah, *et al.,* (2017) science teaching materials can improve students' metacognition abilities. Their scientific approach encourages students to seek out information through observation. The scientific approach to creating an active learning (Kementrian Pendidikan dan Kebudayaan, 2016).

Procedural knowledge contained in the exploration phase and questioning phase. Such knowledge encourage students to do something to solve the problem (Winkel, 2004). Statement questionnaire covering procedural knowledge, know the steps, know the reason for selecting, aware of the plan to use, find kesulitasn, choosing learning strategies, and identify strategies to learn automatically. The questionnaire statement is presented in Figure 5 on the PK indicator with a score of 63% which is categorized as good, as well as Bahiyah, *et al.,* (2019) metacognition was well developed. Based on the survey results, it was found that the students have not yet independently applying maximum CVS to implement the learning process. Teachers provide instruction to students in implementing measures CVS and scientific approach. CVS is very helpful in creating an effective learning process and helping students in achieving their stated objectives indicators developed. CVS beneficial for the abstraction of learners with naturalistic environment give more to provide opportunities and resources to learn than just reading a book, as well as facilitate learners to transfer knowledge (Hofer, Schumacher, Rubin & Stern, 2018; Chan & Schunn, 2015; Dunbar, 2001; Schauble 1996).

Conditional knowledge contained in the exploration phase and questioning stage. The knowledge regarding when and why to use a strategy, techniques, and specific methods to solve the problem (Paris, et al,. 1983 Schunk, 2012) statement conditional questionnaire covering knowledge, understanding and meneyeleksi information, realize that simplify matters, adjust steps to resolve, think through the steps, to motivate yourself, and learn better. The questionnaire statement is presented in Figure 5 on the CK indicator with a score of 66% which is categorized as good. According Desmita (2009), students who have a good idea is the learners who use strategies on a regular basis to solve the problem and find out when and where to use tergsebut strategy.

Monitoring contained in the training phase and gathering information stage. Ulfa (2009) stated that the understanding has a very fundamental because without understanding, then knowledge and attitude is not meaningful. The knowledge associated with the skills to identify problems and to check the information that is known and we know do. Monitor comprehension questionnaire statements include, identifying concepts and variables, thorough, consider some ways, study hard, considering the needed information, and express ideas. The questionnaire statement is presented in Figure 5 on indicator M with a score of 73% which is categorized as good.

Planning contained in the training phase and gathering information stage. The capability is one example of the regulatory component of metacognition. The function of these capabilities that illustrate the problem, plan the process and record the necessary equipment. Statement questionnaire covering planning, using charts, unyielding determine the answer before solve the problem, set the time, and resolve problems with reading in detail. The questionnaire statement has a value of 71% can be categorized either. According OLRC News (2004), this capability is the ability to plan learning activities. Experimental activity followed by learners with enthusiasm. Nearly the whole learners bring the tools and materials needed.

Evaluation contained in the assessment phase and associate and communicate stage. The evaluation is the ability to decide the solution to a problem and to analyze the performance and effectiveness of the strategies used. The statement includes the evaluation questionnaire, linking the problem to the solution, checking the understanding, asking the answer, checking the answer, making summary, and reflecting. The questionnaire statement is presented in Figure 5 on indicator E with a score of 77% categorized as excellent.

Students' metacognition skills show better awareness in terms of planning, monitoring, and evaluating the problem solving process during and after learning (Amir, *et al.,* 2018). The teacher facilitates the improvement of students' metacognition abilities by carrying out activities

that support these abilities (Iskandar, 2016; Sadikin, *et al.,* 2016; Widadah, *et al.,* 2013; Romli, 2010).

CONCLUSION

The conclusions of this study are: CVS with scientific teaching material has effect on metacognitive ability of learners. Metacognition ability pre and post intervention has increased in both the experimental group and in the control class, however, the increase of the control group which obtained the conventional learning is considered low. There are differences in the average results of the ability of metacognition in the experimental group and a control group of learners.

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