THE EFFECTIVENESS OF HEAT TRANSFER PRACTICUM WITH CARD SORT MEDIA TO STUDENTS' CRITICAL THINKING ABILITY

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Article Info

Abstract

This research aims to know the effectiveness of media cards (Card Sort)-based experiments to improve students' critical thinking skills. The design of this research is the control group pretest-posttest design. Samples were taken in purposive sampling and obtained Class VII F as a Class VII and class B experiments as a control class. This research data is the data value of the posttest and observation data of critical thinking skills of students. The results of this study indicate that the average value of experimental class posttest is 79.18 66.25 control and class. The t-test analysis results in 4.62 whereas t table 1.67. Based on observation, analysis results in the average rating on the class control at each meeting of 36% (not critical), 53% (quite critical), 66% (critical) while the average in class experiments at each meeting is 52% (quite critical), 69% (critical).

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INTRODUCTION

Natural Science is a group of knowledge arranged systematically to learn natural phenomena where its development is assigned to the collection of facts with scientific methods and behavior (Trianto, 2010). Natural science in middle school is done by using a scientific approach which is also used in the learning process of Curriculum 2013 (Abidin, 2014).

Learning process includes the steps of students developing their cognitive, affective, and psychomotor skills (Amri, 2013). This thing aims to make students able to reach the goals of competences in Curriculum 2013 as they are no longer become the object in the learning process, the subject instead with being involved in developing the theme and material. The process of science learning in Curriculum 2013 uses the scientific approach in which some steps included: formulating problems, proposing the hypothesis, collecting data, managing and analyzing data, and concluding (Abidin, 2014).

In scientific approach, students are supported to construct their understanding. It aims to make students able to apply their knowledge after the learning process of science directly and actively. One of the systems which can involve students actively is practicum. Practicum is the part of the learning process which aims to make students get a chance to test and execute their understanding to the real-life situation (Parmin and Sudarmin, 2013).

Practicum is one of the activities which are in line to scientific learning where practicum is the tool to prove something abstract to reality; thus, students can understand the concept. The process of learning science should emphasize on giving direct and real experience to students (Savitri and Sudarmin, 2016). It is in line to Morrison and Estes (2007) stating that scenario application of real-world experience is an effective strategy to teach science as a process. Wright (2001) also says that students will be easy to understand the material when they do the certain activity to learn that it makes them enjoy the process. Students should be able to construct the understanding in their mind; since, basically, science cannot be separated as facts or proportion; nonetheless, reflecting the skills which can be applied (Mahendra in Marlina, 2011). Through practicum, students can discover practical experience and skills; not only concepts of knowledge.

The observation in SMP Negeri (State Middle School) 2 Magelang showed that practicum was not done optimally; thus, it is meaning and concepts which should be planted to students cannot be delivered well. The low understanding of concept shows the low score of final science exam where students who passed were less than 50%. Not only from the understanding did students also not have good critical thinking skills. It was shown that they were still shy and afraid of doing the instruction in the book of practicum guidance, passive in arguing, and incorrect in concluding practicum.

Therefore, there should be a creative media which can optimize practicum. One of the creative medias which can stimulate and train students' skills is using card sort of which can teach students concept, grouping characteristics, facts of the certain object, or simply repeating information (Silberman, 2009). A card sort is a sorted card with main card and information card containing the materials learned by students. It is directed to invite students discovering concepts and facts through the classification of materials discussed in the learning process (Sisca, 2014). Students are required to find parts of materials owned by other students and adjust it to theirs. They can review the materials in practicum meaningfully.

The card sort is used to help students to develop their skills of providing a simple explanation, building basic concepts, making the conclusion, giving further explanation, strategy, and tactic, and less afraid to do the instruction; thus, students can feel a meaningful practicum. Practicum-based learning is the same to students' condition which is active in learning process making this media raised as a creative one. Creative learning can make students independent, focus, brave, intelligent, and creative. It is by scientific approach to building students' good character (Suastra, 2010). Learning process through the practicum with card sort is hoped to be able to apply the concept well, including improving their critical thinking.

Critical thinking is a systematic process of students to formulate and evaluate their beliefs and opinion (Johnson, 2014). Fisher (2008) defines critical thinking as (1) a behavior of thinking deeply about certain problems in people's experience (2) knowledge of observation method and logical explanation, and (3) as skill to apply methods; critical thinking requires hardworking to check every belief or assumptive knowledge as the supporting prove and further

conclusion. Ennis (2011) states that there are some aspects of critical thinking; providing the simple explanation, building necessary skills, concluding, giving further explanation, and checking strategies and tactics. Through practicum with card sort, it is hoped that students' critical thinking aspects will be improved; thus, the research will be directed to know its effectiveness. This research is aimed to unveil the effectiveness of card sort in heat transfer materials to improve students' critical thinking skills.

METHODS

This research was an experimental research with quasi-experimental design-nonequivalent control group design. In this design, experiment group or control group was not chosen randomly. The design of the research can be seen in Figure 1.

Group	Pretest	Treatment	Posttest
E	O_1	X_1	O_2
K	O_3		O_4

Figure 1. Nonequivalent Control Group Design
Notes:
E   = Experiment Group
K   = Control Group
O_1 = Pretest of Experiment group
O_2 = Posttest of Experiment group
O_3 = Pretest of control group
O_4 = Posttest of control group
X_1 = Treatment to experiment group with card sort in heat transfer materials.

The samples of this research were taken with purposive sampling using the consideration of teacher based on final science exam. The average score of the classes was relatively the same. The used samples were class VII B as control class and VII F as the experiment class. Independent variable of this research was the practicum of heat transfer material assisted with card sort, and the dependent variable was the critical thinking skills of students.

The instrument of this research was the syllabus, lesson plan, observation sheet of students' critical thinking, students' worksheet, the items of test which have been adjusted to students' critical thinking skills, and evaluation tools of test items. The data analysis was done quantitatively for the validity, reliability, item difference and difficulty, t-test, normality test (posttest and students' critical thinking skills), and descriptive analysis (critical thinking skills).

Descriptive competence based was done using observation. It is used to strengthen the data from the test. The measurement of the observation was using observation sheets which were filled by observers where the score was obtained from them and converted for a score. The criteria of scoring can be seen in Table 1.

Table 1. Scoring Criteria to Students' Critical Thinking Skills

Percentage	Scoring Criteria
82% ≤ score ≤ 100%	Very Critical
64% ≤ score ≤ 81%	Critical
45% ≤ score ≤ 63%	Fairly Critical
25% ≤ score ≤ 44%	Not Critical

RESULTS AND DISCUSSION

The research in SMP Negeri 2 Magelang with card sort to transfer heat material obtained this following data: The first analysis was homogeneity test to the pretest and obtained that experiment and control class had 32 students, the F_{count} to each class was 0.789. Since the significance was 5% and dk= n-1; thus, F_{table} = 1.82; thereby, $F_{count} < F_{table}$, meaning that the data had the same variance or homogenous making the sampling method used purposive sampling.

The analysis of final data was done to answer the hypothesis. In this step, the used data was students' learning result (test instrument) and observation score of students' critical thinking. Posttest score analyzed the data of students' critical thinking. The score was then tested for its normality. If the data had the normal distribution, the statistics would use parametric analysis; while if it is not nonparametric statistics is used. Then, the t-test was done to the posttest score.

Students' critical thinking was measured using test, observation sheet, and questionnaire. The scored aspects of critical thinking were the ability to provide simple explanation, building basic skills, concluding, providing further explanation, and setting the strategy and tactic. The aspects of critical thinking skills were measured by the objective test in pretest and posttest, while the measurement of critical thinking was observed during the learning processes. The measurement of students' critical thinking was the theme of heat transfer with card

sort from pretest and posttest. The comparison of posttest score from the experiment and control class was used to know the effectiveness of card sort. Significance test was used to know the effectiveness of card sort in heat transfer practicum to students' critical thinking where both classes' average posttest score had been used for normality test. Normality test was done to know whether the data were normally distributed or to determine the used statistics. The result of normality test showed that the data were normally distributed; thus, the statistics used were parametric statistics. After the data normality was obtained, its significance was tested. This significance test measured to know the cognitive difference of both classes regarding critical thinking. The result can be seen in Table 2 as follows.

Table 2. The Result of Significance Test to Experiment Class and Control Class

Class	Dk	T_{count}	T_{table}	Criteria
Control and Experiment	62	4.624	1.67	Ho was accepted if $t_{cpunt} < t_{table}$

Table 1 showed that $t_{count} > t_{table}$; thus, Ho was rejected. In conclusion, there was a significant difference in the posttest result of the experiment and control class, which means the card sort was effective to improve students' critical thinking skills.

It is in line with students' positive responses where 84.3% states their interest to the media in the practicum of heat transfer. The interest of students to card sort affected their understanding in discovering concept, different heat transfer and its implementation to daily life independently; thus, the average posttest score was higher than the control class. Learning media is the mediator to deliver the message and stimulate the learning process to students (Aqib, 2013). Thus, teachers have to possess the understanding and giving examples of the learning media (Arsyad, 2013). Warsono and Hariyanto (2013) give examples of media in the learning process. In a class setting, there should be room for students to walk around the class. The steps of card sort learning were (1) distribute different categories of card sort to students; (2) ask the students to walk around the class to find the card with the same category; (3) if the time is enough to let the students find it by themselves. If it is not enough, then the teacher should give the information regarding all categories; (4) ask the students to deliver presentation after they have collected the cards and the other can

respond to what they deliver; and (5) evaluate important point of the learning materials. Card sort present materials about heat transfer in each meeting. The language used was understandable and easy to use by students. The result of the research showed that 23 (71.875%) students passed the passing grade in the experiment class. Meanwhile, there were only 10 (31.25%) students in the control class who passed the posttest. This significant difference was caused by the use of card sort in the learning process proving that card sort was effective to improve students' critical thinking in experiment class.

Critical thinking skills were also measured using observation method. It was to strengthen the data of the test. The observation used observation sheets given to observers. The analysis used descriptive analysis where the score of critical thinking skills from the observer was converted in the form of scoring and then presented. The average critical thinking score in control class or experiment class can be seen in Table 3. Based on Table 3, there was a significant improvement from the first to the third meeting. It is because of card sort was really helpful to students in understanding every material and student can actively follow the learning process; while the control class only listened to the materials from teachers and did the ordinary practicum without any review.

The average score of students' critical thinking to both classes experienced improvement from the first to the second meeting. It was caused by the learning process with the card in experiment class was helpful to students in accepting the learning process and material. Meanwhile, the control class can adapt to the practicum only. According to Khusniati (2012), practicum should also be able to insert character building of responsibility; since students should do their tasks, appreciate others' opinion, creative, discipline to their task, and able to tolerance difference of opinions. Group discussion is also able to make students combine ideas and experiences (Parmin *et al.*, 2016). The score of critical thinking of students in the third meeting of experiment class experiences significant improvement. It was caused by students who have been adapted to practicum with card sort and making a report from it. In control class, some aspects of critical thinking were also improved insignificantly.

Table 3. Average Critical Thinking Score in Experiment Class and Control Class in Each Meeting

Aspects of Critical Thinking	Control Class			Experiment Class		
	Meeting 1	Meeting 2	Meeting 3	Meeting 1	Meeting 2	Meeting 3
Aspect 1	48 (critical enough)	66 (critical)	80 (critical)	56 (critical enough)	70 (critical)	90 (very critical)
Aspect 2	27 (not critical)	49 (critical enough)	60 (critical enough)	56 (critical enough)	70 (critical)	88 (very critical)
Aspect 3	40 (not critical)	56 (critical enough)	77 (critical)	44 (not critical)	67 (critical)	84 (very critical)
Aspect 4	45 (critical enough)	58 (critical enough)	76 (critical)	61 (critical enough)	76 (critical)	85 (very critical)
Aspect 5	26 (not critical)	32 (not critical)	45 (critical enough)	42 (not critical)	63 (critical enough)	74 (critical)

Note:
Aspect 1: providing simple explanation
Aspect 2: building basic skills
Aspect 3: concluding
Aspect 4: providing further explanation
Aspect 5: setting strategy and tactic

Because of practicum, card sort and reports made students able to work collaboratively. Mayangsari (2016) shows that practicum with only students' worksheet can improve students' critical thinking. Developed skills through team collaboration made students active with varied skills; thus, they can show it to in group activities. It was because active learning guided students to improve their skills and scientific works (Kemendikbud, 2014). As the research of Pamelasari and Khusniati (2014), most of the college students (82%) will choose outdoor learning with active, joyful, and ease to their understanding.

The result in Table 3 showed that the improvement of students' critical thinking was higher to control class. It showed that card sort in heat transfer could improve students' critical thinking. It was in line to previous researchers who were able to improve students' critical thinking (Susantini *et al.*, 2012; Ariyati, 2010). Specifically, Kurnianto (2009) proves that concluding and communicating can be developed through learning with practicum methods. The implementation of the practicum will be effective with the help of card sort; whereas, card sort is a collaborative activity which can be used to teach concepts, characteristics, classification, facts, or object or reviewing information that these strategies are used to invite students finding concepts and facts through material classification in learning process.

As to Zinal (2008), the strength of card sort in learning can improve students' activity cognitively or physically become joyful learning since there was a game that can improve students' bravery and disciplines. This statement can be said as the application of card sort which can improve students' activeness whether visual, oral, audio, kinetics, or written. Wasilah (2012) also says that students' ability in reporting the practicum can be improved using the card. It is supported by Anis (2013) that the implementation of card sort can improve science learning result.

The result of the research showed that the practicum of heat transfer was effective to improve students' critical thinking with t-test of t_{count} 4.624 > t_{tabel} 1.67. It was supported by the observation where there was the improvement to the experiment class due to the treatment.

CONCLUSION

Based on the research, it can be concluded that the application of practicum to heat transfer material with card sort was effective to improve students' critical thinking with t_{count} = 4.624 > t_{table} = 1.67.

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