

Effectiveness of Guided Inquiry Model Student Worksheet to Improve Critical thinking Skill on Heat Material

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Abstract—This research aims to describe the effectiveness of guided inquiry model student worksheet to improve critical thinking skill on heat material in terms of learning outcomes. The research used Control Group Pretest-Posttest Quasi-Experimental Design. The subjects of this research were VII grade of U1 and U2 students of Junior High School 1 with a total of 60 students. The research subjects were determined by using purposive sampling technique. Data collection was conducted by performing test. The results of data analysis with Independent Samples t-Test showed sig. value of 0,022. Because sig. value $\leq 0,05$, H_0 was rejected or H_1 was accepted. Product effectiveness level based on the mean of normalized gain from pretest and posttest value of experimental and control groups demonstrated that N-gain of experimental group was 0,48 and N-gain of control group was 0,38. Therefore, it can be stated that the improvement of students' critical thinking skill of experimental group or group which used development product student worksheet was higher than the improvement of students' critical thinking skill of control group which used conventional student worksheet. It can be concluded that the learning which uses guided inquiry model student worksheet is more effective in improving critical thinking skill than the learning which uses conventional student worksheet.

Keywords— student worksheet, guided inquiry, critical thinking skill.

I. INTRODUCTION

The quality of education in Indonesia, especially Natural Science (science), is still low. Based on PISA data, Indonesia, in terms of science literacy, always scores far below the international average score. Indonesia can only occupy the top 10 lowest rank of the participating countries (PISA, 2012). The low quality of science education in Indonesia is a manifestation of the application of teaching patterns which are less suited to the demands and the needs of students. The partially applied learning process still uses lecture method that causes students to

play a passive role and tend to be the only recipients of science products. The learning process needs to be changed, which is initially teacher-centered, to learning which involves students and challenges them using scientific methods in problem-solving so that it can increase the participation and generate curiosity in learning, improve understanding and mindset as well as help students to develop critical thinking skill. According to Wardani, et al. (2013), students do not only listen to lectures from teachers about a material, but students can also experience the process to get the concept, so that students' understanding of a concept or principle will be greater.

The efforts of government to improve the quality of education are conducted by improving the curriculum, from the Education Unit Level Curriculum (KTSP) 2006 to the 2013 Curriculum. The 2013 curriculum obliges to provide the essence of the scientific approach in learning of science. The scientific approach is an approach that will shape individuals to have critical and characterized attitudes. In order to build the critical and characterized attitudes in students, an appropriate learning model such as scientific discovery learning model, problem-based learning model, and other learning model that build critical and characterized attitudes of the students are needed (Rizqi, et al., 2013; Afidah, et al. 2013).

This scientific approach can be integrated in one of the learning tool components in the form of Student Worksheet (LKS). Student Worksheet, according to Wijayanti, et al. (2015), is a printed material in the form of sheets of paper containing materials, summaries, and instructions on the learning task implementation that must be done by the students, which refers to the basic competencies that must be achieved.

One of the purposes of the use of Student Worksheet in science learning is to provide opportunity for students to actively involve themselves in finding a concept through observation and experimental activities, so that the

learning becomes more meaningful. In developing the teaching materials (Student Worksheet) a proper model is also needed. Learning model which is considered quite effective in science learning is inquiry model (BSNP, 2006).

Inquiry is derived from the word "inquire" which means "seeking" or "questioning". Learning by using inquiry approach, according to Wenning (2011): When taught using the levels of inquiry approach, students have the opportunity to make observation, formulate prediction, collect and analyze, develop scientific principle, synthesize laws, and make and test hypotheses to generate explanation. Guided inquiry learning is more constructive, it gives students the opportunity to ask questions and share learning experiences, as well as to improve students' knowledge and develop critical thinking skill. Guided inquiry learning can make students to think critically. The ability to think critically can tackle the cognitive, affective and psychomotor aspects. It is in accordance with Azwar's research (2015), that students' critical thinking can influence learning outcomes. Critical thinking stimulates each student's cognitive structure to capture ideas, concepts and to organize the knowledge they owned to improve the development of students' proficiency and readiness.

Inquiry is applied in order to make students participate more actively in learning and to find knowledge in their own way. Knowledge that is found by constructing the knowledge itself through real experience will be more meaningful than the knowledge which is remembered or memorized (Sanjaya, 2012). Learning by using inquiry model that is suitably applied to junior high school students is guided inquiry model. The use of guided inquiry is chosen because students have not been accustomed to learn to use inquiry model beforehand.

According to Sagala (2013), thinking is the process of describing the characteristics of an object, placing two relationships between two verbally formulated definitions, and drawing conclusion as the work of reason in the form of a new opinion based on the existing opinion. The ability to think is the basic in a learning process (Heong, et al., 2011). In addition, according to Rustaman (2005), thinking habituation needs to be instilled at the early age through science learning. Critical thinking skill is needed in the current science and technology (IPTEK) development era because the result of Science and Technology (IPTEK) development not only can be enjoyed, but also can generate some impacts that create problems for human life and the environment. The problem is complex enough that it needs high-level thinking skill to solve the problem.

Critical thinking is thinking based on reasons and thinking reflectively by emphasizing decision-making on what should believe or do, Ennis (in Costa ed., 1985). The ability of critical thinking has an important role because it is a provision of life success that prepares students to be clever to explain the reasons, able to make good information assessment and able to solve problems that have not been known (Cheong and Cheung, 2008). Critical thinking skill is included in one of the 21st-century learning and innovation skills that enable students to effectively address social, scientific and practical issues in the future (Snyder and Snyder, 2008).

Students who are accustomed to conduct critical thinking training know more about how to think in a purposeful, planned and logical way according to the facts that have been known so that it can result in the acquisition of more optimal learning outcomes (Haseli & Rezaei, 2013). Indicators of critical thinking skill are divided into 5 groups (Ennis in Costa ed., 1985) namely: 1) Providing a simple explanation (*elementary clarification*), 2) Building basic skills (*basic support*), 3) Making inferences (inferring), 4) Generating further explanation (*Advanced clarification*), and 5) Setting strategies and tactics (*strategy and tactics*).

This research aims to describe the effectiveness of guided inquiry model student worksheet to improve critical thinking skill on heat material in terms of learning outcomes.

II. RESEARCH METHOD

This research was *quasi-experimental* research. The design used in this research was *Pretest-Posttest Control Group Design*. The subjects of the study were VII grade of U1 and U2 students of SMPN 1 Gisting with a total of 60 students. Research subject was determined by using purposive sampling technique. Research data were collected through critical thinking skill tests. The data analysis of test result was used to measure the effectiveness level of the usage trial (*Pretest-posttest Control Group Design*) with *Independent Sample t-Test*. Prior to data analysis, normality test were performed using *Kolmogorov-smirnov* and homogeneity test with *Levene's* test.

III. RESULTS AND DISCUSSION

The Results of the Research

The implementation of guided inquiry model student worksheet to improve critical thinking skill was performed during three meetings for the subject of heat, two meetings for the learning and one meeting for the test. There were five stages of learning approach with inquiry model as stated by Wena (2009), namely: (1) problem

presentation; (2) Collection of verification data; (3) Collection of experiment data; (4) organization of data and formulation of conclusions; and (5) analysis of inquiry processes.

The level of the concept mastery of students was measured by using the concept mastery instrument in the form of *essay* test as many as 10 items concerning on heat material. The test instruments used to measure the critical thinking skill were based on indicators of critical thinking skill and, according to Ennis (in Costa ed., 1985), they were outlined from the four dimensions of critical thinking skill namely providing simple explanation (*elementary clarification*), building basic skills (*basic support*), inferring (*inference*), and generating further explanation (*advanced clarification*).

The result of descriptive statistics test of *posttest* value data in experimental and control groups can be seen in Table 1.

Table.1: Descriptive Statistics of Posttest Result Value Data

		Posttest Experimental Group	Posttest Control Group
<i>N</i>	<i>Valid</i>	30	30
	<i>Mising</i>	0	0
<i>Mean</i>		70,83	67,18
<i>Std. Deviation</i>		6,86	5,01
<i>Minimum</i>		58	55
<i>Maximum</i>		90	75

Table 1 demonstrates that the *posttest* mean value of experimental group is 70,83 and the *posttest* mean value of control group is 67,18. This results shows that the *posttest* mean value of experimental group is higher than the *posttest* mean value of control group.

The result of *posttest* data normality and homogeneity tests of experimental and control groups are presented in Table 2 and Table 3.

Table.2: The Result of Posttest Data Normality Test

Group	Sig. (2-tailed)	Conclusion
Experimental	0,200	Sig. $\geq 0,05$ = Normal

Control	0,200	Sig. $\geq 0,05$ = Normal
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Table 2 depicts that the significance value of experimental group and control group is the same, which is 0,200. It means that sig. (significance) value or probability value of both groups $\geq 0,05$, so that H_0 is accepted, which means that the research data are derived from normally distributed data.

Table.3: The Result of Posttest Data Homogeneity Test

Levene	df1	df2	Sig
1,826	1	58	,182

Table 3 demonstrates that the significance value of *posttest* data homogeneity test of experimental and control groups is 0,182. Because sig. (significance) value or probability value $\geq 0,05$, so H_0 is accepted, which means that both groups have the same or homogeneous variance.

The qualification result of students' critical thinking skill of experimental and control groups based on the mean score of *posttest* value can be seen in the Table 4.

Table.4: The Qualification of Critical Thinking Skill

Group	Mean Score	Category
Experimental	65,5	Critical
Control	60,68	Less Critical

Source: Dwijananti (2000)

Table 4 demonstrates that after conducting a learning using guided inquiry model student worksheet, the result of experimental group development obtains a mean score of 65,5 with 'critical' category, while in the control group, after conducting a learning using conventional student worksheet, a mean score of 60,68 with critical thinking skill category of 'less critical' is obtained.

The result of difference test of two means between experimental group and control group using t-test (*Independent Samples t-Test*) can be seen in Table 5.

Table.5: The Difference of Posttest Data Mean

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig.(2-tailed)
					Lower	Upper			
Pair									
1	Experimental Group	70,83	6,865	1,253	0,545	6,755	2,4	58	0,022
	Control Group	67,18	5,008	0,914					

Table 5 shows that the sig value. (2-tailed) <0,05, so that it rejects H_0 and accepts H_1 . This result indicates that there is a significant difference between the mean value of critical thinking skill of experimental group students and the mean value of critical thinking skill of the control group students. The level of product effectiveness based on the mean of normalized gain of the pretest and posttest values of the experimental and control group is obtained as it is in Table 6.

Table.6: N-gain Value of Experimental Group

Group	< g > (N-gain)	Classification	Effectiveness Level
Experimental	0,48	Moderate	Quite Effective
Control	0,38	Moderate	Quite Effective

Source: Hake (2000)

Table 6 shows that the N-gain value of experimental group is 0,48 and the N-gain value of control group is 0,38. N-gain value of experimental group is higher than the N-gain value of control group.

The increase of N-gain in each dimension of critical thinking skill for each student group is presented in Figure 1.

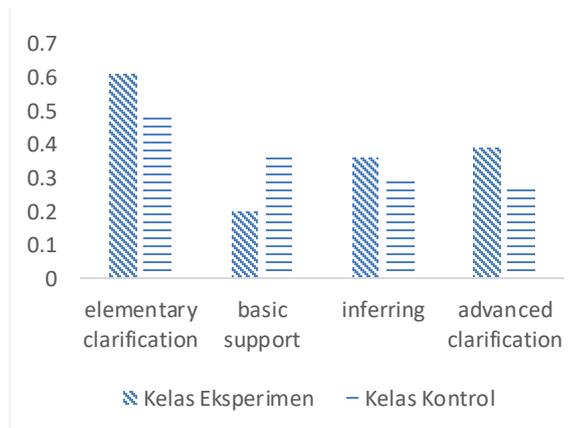


Fig.1: The Increase of N-gain in Each Dimension of Students' Critical Thinking Skill

Figure 1 above indicates that the highest N-gain value of critical thinking skill is in the dimension of elementary clarification (providing simple explanation) either in experimental group or in control group. While, the lowest N-gain of experimental group is in the dimension of basic support (building basic skills).

IV. DISCUSSION

Hypothesis testing in this research was conducted by using SPSS 21 program.

The results of descriptive statistical test of pretest-posttest value data in the experimental and control groups were obtained that; the mean pretest value of experimental group was 33,17 and the mean of pretest value of control group was 35,07 while the mean of value of experimental group was 70,83 and the mean of posttest value of control group was 67,18. These results indicated that the mean value of experimental group posttest has increased. The mean value of the experimental group posttest was bigger than the mean value of the control group posttest.

The implementation of guided inquiry model student worksheet resulted in the improvement of student learning outcomes. The student learning outcomes of experimental group which used guided inquiry model student worksheet was greater than the student learning outcomes of control group which used conventional student worksheet. This result also means that students' critical thinking skill in the experimental group were better than the students' critical thinking skill in the control group. The implementation of guided inquiry model student worksheet in the experimental group could improve students' critical thinking ability. This was in accordance with the research conducted by Sohibin's (2009) that the guided inquiry model can improve students' understanding of concepts and develop students' critical thinking skill. The research of Tindangen (2007); Azizmalayeri (2012); Fuad, et al. (2017) proved that

inquiry learning contributes in improving critical thinking skill.

The student learning outcomes in the experimental group were improved due to the learning which used guided inquiry model student worksheet which allows students to be actively involved both physically and mentally in the learning process. Students gained the experience directly, students were more interested in learning, and student learning motivation increased. These things were supported by previous research conducted by Winarni (2009) who stated, "Through inquiry, teachers invite students to be more active both physically and mentally in the learning process". Rachman et al (2012) stated, "The application of guided inquiry model can improve student learning activities". Laubach et al (2010) said, "With inquiry learning, students can be more interested in the learning that is taught because students get the experience directly". Patrick et al. (2009) said that guided inquiry can improve students' motivation in the learning of science.

The results of *Posttest* data normality and homogeneity test of experimental and control group in Table 2 and Table 3 showed that *posttest* data of both groups were derived from the same or homogeneous and normally distributed variance. Based on this reason, t-test (*Independent Samples t-Test*) was conducted. Prior to analysis of product effectiveness level using t-test (*Independent Sample t-Test*), *pretest* and *posttest* result data on critical thinking skill assessment were analyzed. The analysis was performed to find out the value of students' critical thinking ability. Having obtained the value of critical thinking skill, the category of critical thinking skill of each student was determined. Category giving aimed to know the qualification of critical thinking ability. The result of the students' critical thinking skill qualification in Table 4 showed that experimental group which used guided inquiry model student worksheet obtained the mean score of the *posttest* value of 65.5 with 'critical' category, while the control group which used the conventional student worksheet obtained the mean score of the *posttest* value of 60,68 with 'less critical' critical thinking skill category.

The result of t-test (*Independent Sample t-Test*) in Table 5 showed that the sig. value obtained was 0.022. Because the sig. value ≤ 0.05 then H_0 was rejected or H_1 was accepted, so it could be stated that the learning using guided inquiry model student worksheet improved critical thinking skill more effectively than the learning using conventional student worksheet. Guided inquiry model student worksheet packaged in the student worksheet improved critical thinking skill more effectively. This was in accordance with the research conducted by Damayanti, et al. (2012) and Sudarmini, et al. (2015).

The product effectiveness level based on the mean of the normalized *N-gain* from *pretest* and *posttest* value of the experimental group and control group obtained the result of the experimental group *N-gain* value of 0.48 with classification of 'moderate' and effectiveness level of 'quite effective', while the control group *N-gain* value was 0.38 with classification of 'moderate' and effectiveness level of 'quite effective'. Based on the calculation of *N-gain* value, it was known that the *N-gain* value of experimental group was bigger than the *N-gain* value of the control group. Therefore, it can be stated that the improvement of students' critical thinking skill of experimental group or group which used guided inquiry model student worksheet was higher than the improvement of students' critical thinking skills of the control group.

Based on the comparison of *N-gain* increase in each critical thinking skill dimension for each group of students, the development result of *elementary clarification* critical thinking skill of experimental group which used guided inquiry model student worksheet was higher than the development result of control group which used conventional student worksheet. The mean of *posttest* value from *pretest* value of experimental group on the critical thinking skill dimension of *elementary clarification* increased because the learning which used guided inquiry model student worksheet allowed students to understand and observe problems from various aspects, to train students to learn in finding problems then make problem formulation based on the facts found. The critical thinking ability of the students was trained and developed by always asking and questioning the various phenomena being studied. It can be attributed to Gengarely's (2009) research which stated that inquiry could teach students how to ask questions in the classroom and to get their own answers. Inquiry could encourage students' scientific thinking habits and students were more open to new ideas in groups or classes, with the hope that students think about the process, not just the final result. An example of problem formulation by student is shown in Figure 2.

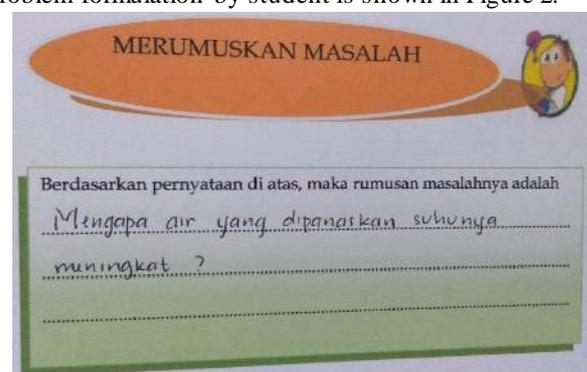


Fig.2: An Example of Problem Formulation

The problem formulation written by the student is correct. The formula is in accordance with the purpose of the experiment, namely the influence of heat towards the rise in temperature. The orientation stage (guiding the students) of learning steps in using guided inquiry model student worksheet model inquiry has trained students to think critically.

The learning by using guided inquiry model student worksheet also allowed the students to use the knowledge they have in the form of temporary answers or hypotheses before conducting experiments. Students' critical thinking skill could be trained and developed through the stage of formulating the problem. This was in accordance with Bilgin's (2009) research that guided inquiry learning model could train students to build answers and think smartly in finding alternative solutions to problems given by teachers, develop understanding skills, and train the delivery process of the concepts found. An example of a temporary answer by a student is shown in Figure 3.

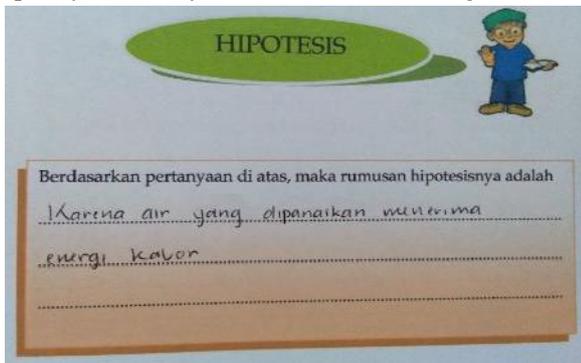


Fig.3: An Example of Hypothesis Formulation

The temporary answer towards the hypothesis formulation put forward by the student is also appropriate. The temperature of an object when heated increased due to the receiving / absorbing energy of heat. Formulating problem stage of learning step in using guided inquiry model student worksheet has trained the students to think critically in using the knowledge they have in the form of temporary answer or hypothesis.

Based on the comparison in *N-gain* increase in each dimension of critical thinking skill for each group of students, the critical thinking skill dimension of *basic support* of experimental group was still lower than control group has (Figure 2), this was possible because students were less accustomed to being trained to think critically in solving problem. Snyder & Snyder (2008) revealed that like any other skills, critical thinking requires training, practice and patience.

The low result of *basic support* dimension strengthens that, in the learning which uses guided inquiry model, the teacher does not just let go of the activities undertaken by the students. Teachers still provide guidance and direction

in the learning activities so that students who think slowly still able to follow the activities that are being held and the students who have the ability to think fast do not monopolize the activities.

The next step of learning is the collection of verification data. In this step, the students collect the data or information through literature review. An example of collection of verification data by a student is shown in Figure 4.

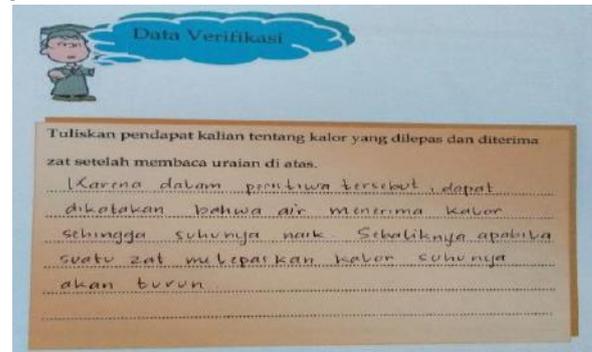
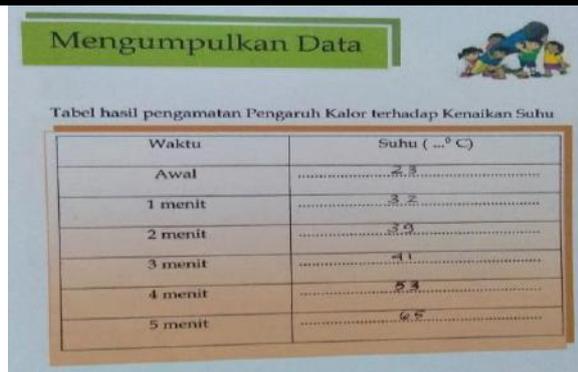


Fig.4: An Example of Verification

Data Collection

Verification data which have been collected by the student is exactly in accordance with the concept, the water receives / absorbs the heat so that the temperature rises. The verification data trains students to think critically and to sort and choose the correct concept according to the objectives which will be achieved through experiment.

The next step is experimental data collection. Students perform experiments in accordance with the existing procedures, followed by recording the data of experimental results. Experimental activities can help students to understand the material more easily and to gain real experience by taking an active role in learning activities and it can train them to practice investigative skills. This is in accordance with Hackling's (2005) statement that the practice of observation or conducting experiment gives students the opportunity to practice and develop investigative skills as well as to gain real-life experience about natural phenomena as the basis of conceptual learning. Experimental activities can also help students to solve problems and to find their own knowledge. This is in line with Ketpichainarong, Panijpan & Ruenwongsa (2010) research that students collect data through experimental activities to solve problems so that students are able to build and discover their own concepts of knowledge. An example of data collection by a student is shown in Figure 5.



Tabel hasil pengamatan Pengaruh Kalor terhadap Kenaikan Suhu

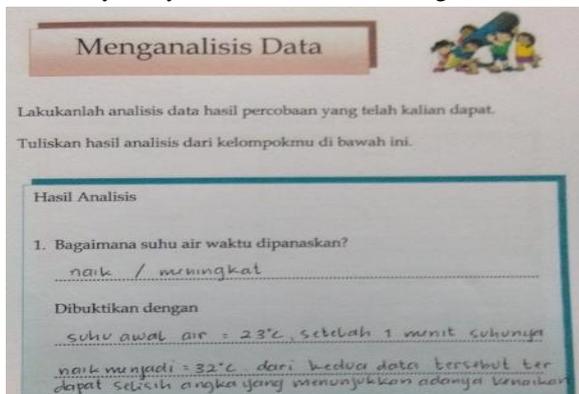
Waktu	Suhu ($^{\circ}\text{C}$)
Awal	23
1 menit	32
2 menit	35
3 menit	41
4 menit	53
5 menit	65

Fig.5: An Example of Experimental

Data Collection

The resulting data of the experiment collected by the student is correct. The longer the heating time, the higher the temperature rise of the object. The high temperature of the object indicates that the amount of heat received by the object increases.

Based on the experimental data, the students performed data analysis. There is a possibility that the resulting data of experiment and the theory is different, so students need to analyze it. Data analysis begins by examining data and ideas, as well as identifying opinions and supporting reasons. Data analysis activity can be performed by building and using ideas that students owned. This is in accordance with the statement of Callahan, et. Al. (1992: 293-294) that data analysis activity can be done by building and using ideas owned by students. An example of data analysis by a student is shown in figure 6.



Lakukanlah analisis data hasil percobaan yang telah kalian dapat.
Tuliskan hasil analisis dari kelompokmu di bawah ini.

Hasil Analisis

1. Bagaimana suhu air waktu dipanaskan?
naik / meningkat

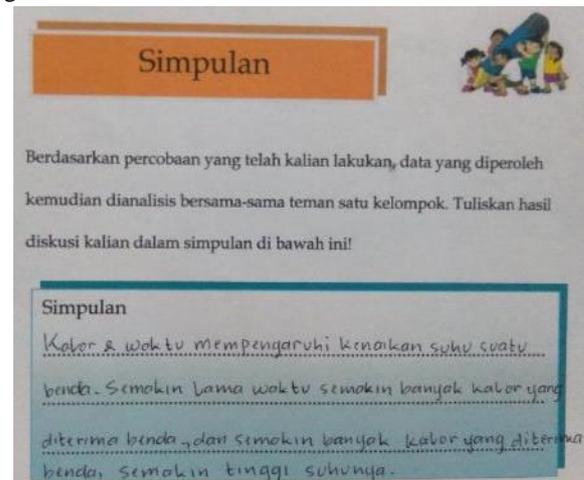
Dibuktikan dengan
suhu awal air = 23°C setelah 1 menit suhunya
naik menjadi 32°C dari kedua data tersebut ter
dapat selisih angka yang menunjukkan adanya kenaikan

Fig.6: An Example of Analyzing Experimental Data

The analysis of experimental data conducted by the student is correct, water temperature rises when heated, the amount of heat received by the object increases. Data collection and analysis stage of the learning step in using guided inquiry model student worksheet has trained the students to think critically and to summarize a number of raw data into information that can be interpreted.

The next learning step is data organization and conclusion formulation. In this step, the teacher guides students to arrange or interpret the experimental results.

Teachers also guide students to make a conclusion. An example of conclusions drawn by a student is shown in Figure 7.



Berdasarkan percobaan yang telah kalian lakukan, data yang diperoleh kemudian dianalisis bersama-sama teman satu kelompok. Tuliskan hasil diskusi kalian dalam simpulan di bawah ini!

Simpulan
Kalor & waktu mempengaruhi kenaikan suhu suatu benda. Semakin lama waktu semakin banyak kalor yang diterima benda, dan semakin banyak kalor yang diterima benda, semakin tinggi suhunya.

Fig.7: An Example of Conclusion

The conclusion written by the student based on interpretation towards the results of the research is correct. Heat affects the rise in the temperature of the object, the more heat it receives, the higher the temperature of the object. The implementation of guided inquiry model student worksheet in the experimental class can increase the critical thinking skill dimension of *inference*.

Based on the comparison in *N-gain* increase for each group of students, the development result of average increase in *inference* critical thinking skill of experimental group which uses guided inquiry model is higher than the development result of control group which uses conventional student worksheet. The mean of *posttest* value from *pretest* value of experimental group on the critical thinking skill dimension of *inference* increases because the learning which uses guided inquiry model student worksheet allows students to describe the findings obtained based on hypothesis testing. To reach an accurate conclusion, students should be able to demonstrate relevant data.

Based on the comparison of the increase of *N-gain* in each critical thinking skill dimension for each group of students, the comparison of *pretest* and *posttest* results of critical thinking skills of the experimental and control groups in the *advanced clarification* critical thinking skill dimension (generating further explanation) and the critical thinking sub defined the terms, considered the definition of classification and range. There was an increase in the mean of *posttest* value from *pretest* value in *advanced clarification* critical thinking skill dimension of 2.85 in experimental group and of 1.95 in control group. The development result of the increase in mean value of *advanced clarification* critical thinking skill of experimental class which used guided inquiry model

student worksheet was higher than the development result of the control group which used conventional student worksheet. The mean of *posttest* value from *pretest* value of experimental group on *advanced clarification* critical thinking skill dimension increased because the learning which used guided inquiry model student worksheet allowed the students to be actively involved in finding their own concept through observation or experiment so that learning activities became more meaningful.

The average increase of *posttest* value from *pretest* value in all dimensions of critical thinking skill in the experimental group showed that the learning using guided inquiry model can improve students' academic proficiency. This is supported by the research conducted by Sari & Sutiadi (2008) that the observed academic abilities were improved after applying guided inquiry learning model. Jannah *et al* (2012) stated that the implementation of guided inquiry could improve the quality of students' conceptual understanding and was able to embed the characters in the students. Wirtha (2008); Suma (2010); Handhika (2010) said that guided inquiry learning could develop the mastery of physics concept.

The average increase of *posttest* value from *pretest* value in all dimensions of critical thinking skill in the experimental group also showed that the learning using guided inquiry model student worksheet improved students' critical thinking skill. This was supported by Hasruddin' (2009) research which stated that the application of inquiry learning can empower students' thinking skill so that it could maximize the critical thinking skill. Prabowo *et al* (2015) stated that the critical thinking skill of students who were taught with inquiry learning model has increased.

V. CONCLUSION AND SUGGESTION

Conclusion

Based on the results of research and discussion, it can be concluded that learning by using guided inquiry model student worksheet packaged in student worksheet is quite effective to improve critical thinking skill. The results of *N-gain* calculation showed that the *N-gain* value of group which used development product student worksheet was higher than the value of the group which used conventional student worksheet. *N-gain* value of experimental group was 0.48 and *N-gain* value of control group was 0.38. The implementation of guided inquiry model student worksheet in the experimental group can improve students' critical thinking skill.

Suggestion

Suggestions from this development research are: (1). Teachers and students should be able to use guided inquiry model student worksheet as a means to improve critical thinking skill. (2). This new development research is conducted on a small scale, hence, further research on large-scale groups should be carried out to determine the feasibility of this product to be applied to large-scale groups.

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