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Comparing the Students' Scientific Literacy Based on Teaching Models and Science Textbook on Expansion Concept

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Abstract---The aim of this study is to determine the differences in students' scientific literacy regarding applied teaching model and science textbook they used in the learning activity. This study used the true experimental method with pretest-posttest control group design. The result of the comparative test using ANOVA showed a different improvement level of students' scientific literacy among 1st and 2nd experiment group, as well as the control group. The highest improvement of students' scientific literacy was found in the 1st group which used science literacy-based textbook (STbL) in combination with the application of guided inquiry teaching model (GI) or so-called GI-STbL. The lowest improvement was obtained in the control group which applied the direct instruction teaching model (DI) without STbL (DI-nSTbL). Moreover, it is strengthened by the gain test result which shows that the increase of students' scientific literacy was in medium criteria, particularly in the 1st group (0.58) and the 2nd group (0.32). Meanwhile, the control group (DI-nSTbL) shows the low standard (0.28). Also, the average score of cognitive, affective, and psychomotor of GI group was higher than DI group. In conclusion, guided inquiry with science literacy-based textbook is effective in increasing the students' scientific literacy.

Keywords: guided inquiry, direct instruction, literacy-based science textbook, scientific literacy

I. INTRODUCTION

In Indonesia, an understanding of the science learning to create students' scientific literacy has not been fully implemented by science teachers. The result of an international level measurement on students' scientific literacy shows that the Indonesian students' ability science was lower than students of other countries in the world [1]. . As publicized by the *program for international student assessment* (PISA), the average score of Indonesian students' scientific literacy is far below the international average score. Indonesia was ranked at 64 out of 65 participating countries with score at 382 [2]. Fortunately, the PISA study in 2015 shows the increase in ranking of Indonesian students' ability at 62 out of 70 countries [3], but in 2018 the ranking dropped.

In addition, the survey was also conducted by *Trends in International Mathematics and Science Study* (TIMSS) which is an international study for 4th grade and 8th grade in mathematics and science. TIMSS performed the determination of students' achievement level all over the world to obtain information about the context of math and science education. The results of TIMSS study in 2011 indicated that Indonesian was ranked 40th out of 42 participating countries with score at 406. The average score of Indonesian students represents the its level is below the international average scores.

The low students' scientific literacy ability indicates the ineffective science learning process in Indonesia. Most learning activities use a teacher-centered learning model which is dominated by direct learning and lecture. The students-centered learning model is rarely applied in classroom. The learning process tends to be less interactive which leads students to have little experience in finding concepts.

Regarding this issue, teachers need to choose a learning model that is suitable for science learning process which can enhance the scientific literacy of students. Science learning should be conducted using a combination of theory transfer through lectures and further investigation through practical activities. By this method, the learning activities become more meaningful. It is in line with the opinion of [4], who stated that learning should be supplemented by an experiment or demonstration activities at least once. This activity is necessary for students to conduct experiments and directly involved in the process to understand a concept.

In addition to learning models to increase the students' scientific literacy, it requires the selection of appropriate teaching textbooks. So far, the textbooks that have been used in teaching are more emphasizing on the content dimension than the context and process dimensions as demanded by PISA. Therefore, it is thought to cause a low level of scientific literacy of Indonesian students [5]. Science textbook that good is accordance with the development of students as well as a proportional contains scientific literacy. The several categories of

scientific literacy to analyze and develop science textbooks are (1) science as a body of knowledge; (2) science as a way to investigating; (3) science as a way of thinking, and (4) the interaction among science, technology, and society. The interaction of science is added with the environment, behind technology and society [6]. The developed a scientific literacy-based science textbook on the topic of heat transfer in daily lives and produced the science textbook that contains scientific literacy with a ratio of 2:1:1:1 sequentially to the fourth aspect of scientific literacy by [7]. Moreover, results of research by [8] showed an improvement of students' scientific literacy which used the literacy-based textbook.

Based on the background explained, this study is conducted in a purpose to increase 7th grade students' scientific literacy by the application of guided inquiry teaching model on the Expansion concept. The study material of Expansion is interesting since its concepts require the direct experimental evidence and such factors that affect the Expansion phenomena. This study used a scientific literacy textbook on the topic of heat transfer in daily lives using the provided Expansion concepts.

Ⅱ. RESEARCH METHODS

The method used is the true experimental method with a pretest-posttest control group design. The study was conducted in Secondary School of Sidaraja 1, Cilacap, Central Java, Indonesia. The population in this study were the 7th grade of F as the 1st experiment group, 7th grade of D as the 2nd experiment group, and 7th grade of E as the control group. Simple random sampling technique was applied in this study. The 1st experiment group used guided inquiry with the scientific literacy-based textbook (GI-STbL), the 2nd experiment group used direct instruction with the scientific literacy-based textbook (DI-STbL), while control group used direct instruction with the regular textbook (DI-nSTbL).

The effectiveness of guided inquiry to increase the scientific literacy of students studied based cognitive score (the pretest and posttest scores), the affective (attitude), and the score of psychomotor (skills). The gain test calculated a significant improvement in the ability of science literacy. The differences of the scientific literacy ability, psychomotor, and affective score of the GI-STbL group, DI-STbL group, and DI-nSTbL group were analyzed using comparative tests with One Way ANOVA by SPSS 16.0 for Windows.

Ⅲ. RESULTS AND DISCUSSION

The results of the gain of students' scientific literacy ability (cognitive), affective assessment, psychomotor assessment, and the test of hypothesis were presented in Table 1.

Based on the results of the hypothesis test, all value of Sig. < α = 0.05; therefore, H_0 is rejected and H_1 is accepted. It means there are differences in the improvement of students' scientific literacy ability, attitudes, and skills in practical activities in the GI-STbL group, DI-STbL group and DI-nSTbL group. To find out where the different group so performed further post hoc test. Based on further post hoc test was known that the increase of scientific literacy ability, attitudes, and skills in practical activities of the students in the 1st experiment group was different from another group. It can be concluded that the application of guided inquiry learning model with science literacy textbook in the GI-STbL group produces the highest learning results.

Table 1 The Increase of Students' Scientific Literacy Level

Value	Group			Sig.
	GI-STbL.	DI-STbL	DI-nSTbL	
Gain of Cognitive	0.58	0.32	0.28	0.000
Affective	55.99	50.81	50.00	0.012
Psychomotor	82.36	75.87	74.32	0.000

Based on the analysis, it shows that the 1st experiment/GI-STbL group and 2nd experiment/DI-STbL group increased by 0.58 and 0.32 in the medium category, whereas the control/DI-nSTbL group an increase of 0.28 in the low category. Based on these results, it is known that an increase in the GI-STbL group was highest among the other groups. The increase of scientific literacy ability in the GI-STbL group which followed by the guided inquiry with scientific literacy textbook could be said to be evenly distributed on each aspect of scientific literacy. It means that no aspect of which has increased at very high and the aspects that have increased very low.

Based on the analysis of pretest and posttest, the data shows an increase in the scientific literacy ability in each aspect of scientific literacy. It includes science as a body of knowledge (1st aspect), science as a way of investigating (2nd aspect), science as a way of thinking (3rd aspect), and the interaction between, science, environment, technology, and society (4th aspect). The increase of scientific literacy ability in each aspect is presented in Figure 1.

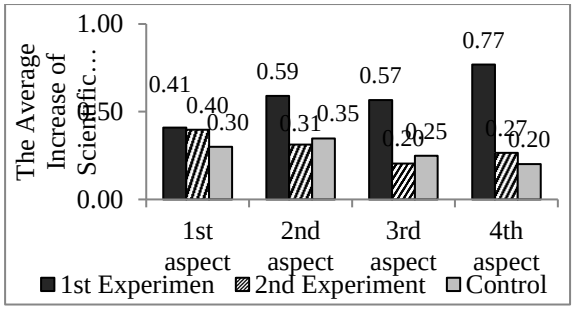

Figure 1 The increase of scientific literacy ability in each aspect

Based on Figure 1, it can be seen that the profile of the enhancement of scientific literacy ability in the GI-STbL group on an aspect of science as a body of knowledge, aspect of science as a way of investigating, and aspect of science as a way of thinking are in the medium category. Also, the aspect of the interaction between science, environment, technology, and society was in the high category. The greatest increase was in the aspect of the interaction between science, environment, technology, and society. This is in accordance with the opinion by [9].

The improvement of scientific literacy ability in the DI-STbL group which followed the direct instruction with scientific literacy textbook was not the same in each aspect. Based on Figure 1, it can be seen that the profile of the scientific literacy ability improvement in the aspect of science as a body of knowledge and aspect of science as a way of investigating were in the medium category. Whereas the aspect of science as a way of thinking and aspect of the interaction between science, technology, and society were in a low category. The highest increases were in the aspect of science as a body of knowledge. The differences of the improvement in each aspect of scientific literacy GI-STbL group and DI-STbL group, because the characteristics of the learning models were applied to both group, was different.

An affective assessment undertaken in this study is the evaluation of student attitudes during the learning process. Aspects assessed attitudes were confident that consists of two indicators ask questions and express opinions. The GI-STbL group achieve an average of attitudes score of 55.99, the DI-STbL group at 50.81, while the DI- nSTbL group at 50.00. The GI-STbL group obtains the average value of the attitude of the exact predicate, while the DI-STbL group and DI-nSTbL group of the less predicate [10]. The average score of student's attitudes GI-STbL group higher than the DI-nSTbL group and the DI-STbL group. Ask questions, and express opinions required great confidence in students because sometimes students feel insecure, shy, and afraid to convey what in their mind in front of his friends. States that to be able to speak fluently in front of the class, students must have a high confidence, so students feel confident in his ability [11].

A psychomotor assessment undertaken in this study is the evaluation of students' skills when carrying out practical work. Assessment of psychomotor seen from four aspects, namely preparation laboratory, practical implementation, data acquisition, and restoration tools. Practical preparation aspects are consists of three indicators, namely preparation of instruments and materials, suitability in assembling tools, and return tools. Aspects of practical implementation composed of two indicators of conformity in the implementation of work methods and accuracy in practical application. Aspects of data acquisition include two indicators of the suitability of the data acquisition and accuracy of data acquisition. Aspects of return tool consist of hygiene tools and practical tables and suitability of a restitution of the instruments and materials. The GI-STbL group achieve an average psychomotor score of 82.36, the DI-STbL group at 75.87, while the DI-nSTbL group at 74.32. The third class achieves an average rating of skills with a suitable predicate [10]. It was caused by the majority of students in the GI-STbL group, DI-STbL group and DI-nSTbL group were more enthusiastic if the learning was performed by the lab rather than just listening to the teacher lecture. The average score of the student's skills in the GI-STbL group was higher than the DI-STbL and DI-nSTbL group. Guided inquiry learning model applied to encourage students to be more creative because students were given the freedom to formulate hypotheses until got the conclusion independently but still under the guidance of a teacher after being given the problems that should be investigated. This result is consistent with research [12], where directions did not restrict students in the class of inquiry. However, they were given the opportunity to discover knowledge through the investigation in more detail than what was done by the students in the non-inquiry group because they were given the specific directions they need to do.

The GI-STbL group increased scientific literacy ability significantly more than the DI-STbL and DI-STbL group. It could be seen based on the score of the gain of each class. This model made learning more meaningful where the knowledge acquired by students become optimal. This result is following the opinion of [13], which states that the inquiry-based learning has the potential to provide a significant advantage to science education with a model of scientific inquiry during the learning concept. Knowledge can not be obtained simply by students with only absorb what is presented by the teacher, but they had to construct their understanding. Define inquiry as a process to find the correctness, information or knowledge that can help the students to more creative and think widely [1]. The principal purposes of inquiry learning according to [14] are

(1) developing the curiosity and motivation of the students to learn science concepts and principles; (2) developing scientific skills of students so they can work as a scientist; (3) accustom the students work hard to acquire knowledge.

The results of the application of guided inquiry learning model are to increase student's scientific literacy ability is higher. Activities of students in learning with guided inquiry model made the students have the scientific literacy ability better. Students have the capacity to explain the phenomenon scientifically, evaluate and design a scientific investigation, and interpret the data and scientific evidence. That students who take the learning in the lab with guided inquiry approach showed an improvement (progress) is significant in scientific literacy ability and process skills [15]. In guided inquiry model, all activities performed by students are conducted with the guidance of a teacher using direct instruction [16].

Students in the GI-STbL group have the increase of each scientific literacy aspects was higher than the DI-STbL group and GI-nSTbL group that used direct instruction. That direct instruction like a rote learning that emphasizes on the acquisition of knowledge or the subject matter and not to do with the activities of the investigate process and proof of knowledge or fact, so the scientific literacy will not be achieved [17]. It is different from guided inquiry learning that makes students as a learning center where students are directed to construct their knowledge and not to rely on the teacher. Students become more motivated to learn to find knowledge rather than just listening to what the teacher explained as the direct instruction learning.

Student learning outcomes to be better than learning the results obtained previously. The learning process is done together can increase the sense of togetherness and brotherhood among the students as each student can share their knowledge with their friend. Guided inquiry is applied to produce a meaningful learning experience that is not easily forgotten. It is also consistent with the opinion of [17] who argued that the application of guided inquiry learning model cause the information or knowledge acquired by students will last a long time in the minds of students.

This study applied guided inquiry learning model with scientific literacy-based textbook. The increase of students' scientific literacy ability with guided inquiry learning model without the designed textbook has not been studied further. We can conclude that this is a limitation of this study.

IV. CONCLUSION

Based on the results of research and discussion, there is a difference in the improvement of students' scientific literacy ability in GI-STbL group which used guided inquiry with scientific literacy textbook, DI-STbL group which used direct instruction with scientific literacy textbook and control group which used direct instruction with the regular textbook. The use of scientific literacy textbook can increase the scientific literacy ability of students; however, the increase was higher if the use of scientific literacy textbook followed by the application of guided inquiry learning model. This result showed that guided inquiry learning model effectively to increase the scientific literacy ability of students.

Based on the results of research and discussion researcher submit the following suggestions; teachers should use guided inquiry learning model and scientific literacy textbook to increase the scientific literacy ability of students. Moreover, it is needed to accustom the students to solve the problem on scientific discourse to increase their literacy skills. Furthermore, teachers need to see the composition of the aspects contained in the scientific literacy textbook that will be used if there are aspects that have not been sufficient. Therefore, the teachers should complete it by adding information in the learning associated with these aspects. Finally, teachers need to increase the intensity of the laboratorium learning where the students will be accustomed to doing inquiry activities and the learning becomes meaningful.

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