Improving Middle School Students’ Quantitative Literacy through Inquiry Lab and Group Investigation

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Abstract. The purpose of this study was to analyze the application of metacognitive strategies learning based Vee Diagram through Inquiry Lab and Group Investigation toward students’ quantitative literacy. This study compared two treatments on learning activity in middle school. The metacognitive strategies have applied to the content of environmental pollution at 7th grade. This study used a quantitative approach with quasi-experimental method. The research sample were the 7th grade students, involves 27 students in the experimental through Inquiry Lab and 27 students in the experimental through Group Investigation. The instruments that used in this research were pretest and posttest quantitative literacy skills, learning step observation sheets, and the questionnaire of teachers and students responses. As the result, N-gain average of pretest and posttest increased in both experimental groups. The average of posttest score was 61,11 for the Inquiry Lab and 54,01 to the Group Investigation. The average score of N-gain quantitative literacy skill of Inquiry Lab class was 0,492 and Group Investigation class was 0,426. Both classes of experiments showed an average N-gain in the medium category. The data has been analyzed statistically by using SPSS ver.23 and the results showed that although both the learning model can develop quantitative literacy, but there is not significantly different of improving students’ quantitative literacy between Inquiry Lab and Group Investigation in environmental pollution material.

1. Introduction
Based on characteristic of biology learning, biology of the twenty-first century is an increasingly turn into quantitative science [1]. Not only mathematician that needs the quantitative data, almost all of the field uses mathematics on their works. Mathematics is an essential aspect which it’s currently still separated by other subjects [5]. Mathematics itself serves as the basis of quantitative literacy. In using mathematics, students are required to have a sensitivity of numerical. Aside from that, the use of numerical data train to critical thinking activities and metacognitive skill. Quantitative literacy is a skill, knowledge, beliefs, habits of thought, dispositions, communications capabilities, and problem-solving skills needed to engage effectively in quantitative issues in the field of work and life. Quantitative literacy is a habit of minds or habits of thinking to create a meaning of numerical information [3].

Nowadays, much of the information presented in numerical data sets. Numbers have long been important in the management of life, but they have never been so ubiquitous as they are now. The new circumstances arrived suddenly with the coming of technology and their application to gathering, processing and disseminating quantitative information. But recently, there is a problem in our...
education implementation which after leaving high school, students will already experience changes in the curriculum. The curriculum has taken into quantitative aspects and the students were not ready to follow the system [4]. In this stage, student confronted into the gap between the curriculum require and the unqualified quantitative literacy skill of the students. Students were not familiar with mathematical applications that demanding quantitative reasoning. Therefore, the quantitative literacy is necessary implanted in the middle school to reduce the gap between curriculum require and the quantitative skill of the students.

The low achievement of the literacy skills of quantitative supposedly occurred because the learning process is not maximized to developing literacy quantitative of students. Based on the findings of [5], learning outcomes are designed by high school teachers through the syllabus that made by National Education Standards Agency. On the syllabus contains the assessment of learning outcomes that are less material to facilitate students in developing literacy skills. This could be a problem in our educational process. So, we need to develop quantitative literacy of students at the school, at least in the subjects of biology.

As we know, biology learning required the students to learn by direct experience and contextual learning, so that students can reveal phenomena around them. To uncover the phenomenon, students need a strategy that bring students to think about how the phenomenon can be revealed, then they could develop into a form of new knowledge. Strategies like these are known as metacognitive strategies. Cognitive strategy is needed to help students figure out what should he know and what he did not know [6]. Learning with metacognitive strategies can be implemented through a variety of ways. We could apply this strategy through inquiry learning model in which students are directed to the learning process [7]. According [8], the long term inquiry-based learning is known could affect the quantitative literacy of students significantly.

Besides Inquiry Lab, there are also various learning models began to be used to maximize educational purposes. [9] found that learning with partner through discussions was good to do to learn something. The students can easily understand difficult concepts if they are able to discuss the issues with friends [10]. This can be done through group investigation [10]. Group Investigation (GI) could put the students to learning actively and train the quantitative literacy skill. So, through this research, we want to know how the learning models can give the impact of students quantitative literacy skill. Of the facts and issues that have been described previously, this research proposed.

2. Method
This study used a quantitative approach with quasi-experimental method that aims to see the effect of Inquiry Lab and Group Investigation learning models on material environmental pollution toward the students’ quantitative literacy. The experimental research groups consist of an experimental class that applied Inquiry Lab learning model and an experimental class that applied Group Investigation learning model. Both of the learning model was modified by Vee Diagram metacognition aspects. Each research groups was given an early test, then treated them with different models, and given a final test. The results of the pretest and posttest of each group were compared.

The study was conducted at a secondary public school in Majalengka on the second semester in the academic year 2015/2016. This research involves 54 students from 7th grade, divided into two experimental classes (27 students in the Inquiry Lab class and 27 students in the Group Investigation class). Subjects of this study were taken by purposive sampling. The instruments that used in this study were pretest and posttest quantitative literacy skills in the form of multiple choice questions, observation sheets of learning process, and questionnaire responses of teachers and students.

The data were analyzed by using SPSS/PC version 23 statistical program, two different t-tests were performed: Paired Samples t-test was conducted to determine whether there was a significant difference between pretest and posttest results in each group, in-group analysis, as a result of the instructional methods used in the study. Independent Samples t-test was performed to identify whether quantitative literacy skill of all Inquiry Lab and Group Investigation were equal or at least similar before the study, and to find out whether students significant changes arise between groups as a result.
of the instructional methods used. Significance level was decided by taking p values into consideration 
p>0.05, meant there was not a meaningful difference, p<0.05 meant there was a meaningful 
difference.

3. Finding and Result

3.1. Analysis of students’ quantitative literacy skills
The result of pretests, posttest and N-Gain of quantitative literacy skills between the Inquiry Lab class 
and the Group Investigation class can be seen on Table 1.

| Variable       | N  | Data | Inquiry Lab | Group Investigation |
|----------------|----|------|-------------|---------------------|
|                |    |      | Pretest     | Posttest            |
| Students’      | 27 | SD   | 22.67       | 61.11               |
| quantitative   |    | %    | 0.49        | 21.60               |
| literacy       |    |      |             | 54.01               |
|                |    |      |             | 0.42                |

According to the results presented in Table 1, the average pretest was 22.67 for the Inquiry Lab 
class and 21.60 for the Group Investigation class. As for the average of posttest score was 61.11 for 
the Inquiry Lab class and 54.01 for the Group Investigation class. The average of N-gain for the 
Inquiry Lab class was 0.49 and the average of N-gain for the Group Investigation class was 0.426. 
Pre-requisite test performed on the data pretest through Kolmogorov-Smirnov test for normality test 
and Homogeneity of Varians for homogeneity test. The results show that the pretest data was not 
normal and not homogenous. Then we calculated the posttest data statistically. Based on the 
calculation, we found that the posttest data was not was not normal and not homogenous. To 
determine the effect of students’ quantitative literacy, we continued to non-parametric hypothesis test 
by using Mann-Whitney U test.

| Table 2. The result of U Mann Withney test on students’ 
quantitative literacy posttest score |
|-------------------------------------|
|                                  | U Mann-Whitney | Z | Asymp. Sig. (2-tailed) |
|-----------------------------------|----------------|---|----------------------|
| 299.000                           | -1.143         | .253 |

When finding in Table 2 are taken into consideration (2-tailed = .253 > p= 0.05), it can be said that 
two research groups did not have significant differences, this indicates that there is no difference 
between the posttest of Inquiry Lab class and the posttest of Group Investigation class. It can be 
concluded that Inquiry Lab and Group Investigation were equal to give effect of students’ quantitative 
literacy. Although there is no statistically differences between those learning models, the students in 
both classes has been developed their literacy quantitative skill because both of classes have the same 
final competences which the average posttest score was higher than the pretest score.

3.2. Analysis of students’ quantitative literacy achievement
Quantitative literation dimension divided into six important skills including interpretation, 
representation, calculation, application-analysis, assumptions, and communication, each defined in 
terms of proficiency level [11]. The elaboration of quantitative literacydimensions can be seen from 
the following table:
Table 3. Comparison of students’ quantitative literacy dimensions

| Group | Interpretation (%) | Representation (%) | Calculation (%) | Application (%) | Assumption (%) | Communication (%) |
|-------|--------------------|--------------------|-----------------|-----------------|----------------|-------------------|
| IL    | 81.5               | 63                 | 40.7            | 29.6            | 57.4           | 50                |
| GI    | 81.5               | 42.6               | 51              | 55.6            | 50             | 38.9              |

The result shows that the highest achievement of quantitative literacy skills in Inquiry Lab class and Group Investigation class was the dimension of interpretation. In both groups, the students has the ability to explain the information of the mathematic form as well. The lowest achievement of quantitative literacy skills in Inquiry Lab class was dimension of application and lowest achievement of quantitative literacy skills Group Investigation class was dimension of communication.

4. Discussion

Based on the pretest analysis, the data shown there was no difference Inquiry Lab class and Group Investigation class on pretest achievement. The mean of Inquiry Lab class was 32,84 (22,67%) and the mean of the Group Investigation class was 31,73 (21,60%). The achievement after learning process of the Inquiry Lab class through Inquiry Lab showed the higher results than the Group Investigation class through Group Investigation. Achievement from Inquiry Lab class was 61,11 (61,11%) and the Group Investigation class was 54,01 (58,92%). Learning through Inquiry Lab tends to get higher mean score than students who learn through Group Investigation. Inquiry Lab and Group Investigation were equal to give effect of students’ quantitative literacy. Although based on statistical calculation shows that there is no differences between those learning models, the students in both classes has been developed their literacy quantitative skill because both of classes have the same final competences which the average posttest score was higher than the pretest score.

Both of the experimental groups adequate to create an active learning environment for the students. Through the active learning, students could train their quantitative literacy. By giving factual quantitative data sets continuously during learning process, students encouraged to construct their new knowledge and develop their quantitative literacy. During the process of learning through Inquiry Lab, students were observed to have an enthusiastic learning. According to [12] inquiry-based learning has a positive impact on student learning achievement. Through this learning model, students and teachers can be more motivated to fill science learning process. Students are conditioned to find out the “something” new by the nature phenomenon directly. Some students claim that the learning process was very fun and it was their first experience in this semester. The results of this study indicate that modified Inquiry Lab learning models by Vee Diagrams metacognitive aspects influenced the students' quantitative literacy. Students' trained to develop their quantitative literacy skill: interpretation, representation, calculation, application/analysis, assumptions, and communication based on the numerical sets data. This finding mostly corroborates the other finding of the studies of [8] according to his research, the long term inquiry-based learning significantly could affect the quantitative literacy of students.

Good achievement result also shown by the students of Group Investigation experimental class. The involvment of students in learning process, could increase the ability of higher level thinking and metacognitive skills and also could create the meaningful learning during the class. The modified Group Investigation learning model could influence the students' quantitative literacy. Students worked with a set of quantitative data that must be investigate. Students are required to make an interpretation, representation, assumptions, calculations, applications, and communications based on their own quantitative data.

Reasoning skills has been developed through this learning activity. This is consistent with the findings of [13] in which the Group investigative learning model can improve students' reasoning ability. Reasoning itself is quite closely related to the students' quantitative literacy. Students' reasoning is the process of making conclusions based on information. It involves complex cognitive processes that need the strategy to organizing all knowledge aspects [14]. Quantitative literacy does...
not only consist of one aspect but involves several aspects including interpretation, representation, assumptions, calculations, applications, and communications, so it needs a strategy to achieve an integration of all quantitative literacy aspects. To achieve this, students are required to have reasoning skill. With that assumption, good reasoning capability can deliver students to good quantitative literacy.

The highest percentage of the Inquiry Lab class has indicated by the dimension of interpretation, followed by representation, assumptions, communications, and applications. While the highest percentage in the Group Investigation class was also interpretation dimension, followed by application skill, calculations, assumptions, representations, communication. Based on quantitative literacy analysis results of students’ posttest, the highest percentage is interpretation dimension. This could happen because the students consider the interpretation of quantitative data, either from graphs or tables are considered easier than other dimensions. Study by [15], shows that the ability of representations, such as create a new chart requires was need more competence than interpretation skill. [16] describe a similar finding, where the result of students' performance on the tasks of interpreting the data was better than the performance of students in representation process. Other dimensions such as calculations, assumptions, applications and communications require more complex cognitive processes.

5. Conclusions
In both of the experimental groups showed an increase in students’ quantitative literacy. Nevertheless, there was no significant difference between learning with metacognitive strategies based Vee Diagram through Inquiry Lab and Group Investigation toward the improvement of students' quantitative literacy. Generally, the student has been able to get high percentage of interpretation skill. This means that student has the ability to explain the information of the mathmatic form as well after took learning process.

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