Profile of Scientific Ability of Chemistry Education Students in Basic Physics Course

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Abstract. The weakness of scientific ability of students in college has been a concern in this case, especially in terms of laboratory activities to support Laboratory Based Education. Scientific ability is a basic ability that must be dominated by students in basic physics lecturing process as a part of scientific method. This research aims to explore the indicators emergence of the scientific ability of students in Chemistry Education of Study Program, Faculty of Teaching and Education University of Palangka Raya through Inquiry Based Learning in basic physics courses. This research is a quantitative research by using descriptive method (descriptive-quantitative). Students are divided into three categories of group those are excellent group, low group, and heterogeneous group. The result shows that the excellent group and low group have same case that were occured decreasing in the percentage of achievement of scientific ability, while in heterogeneous group was increased. The differentiation of these results are caused by enthusiastic level of students in every group that can be seen in tables of scientific ability achievement aspects. By the results of this research, hoping in the future can be a references for further research about innovative learning strategies and models that can improve scientific ability and scientific reasoning especially for science teacher candidates.

1. Introduction

Education is one of the people needs that must be fulfilled and improved, especially the quality of teachers and students. Many problems are often encountered in the educational process that a teacher just gives or transfers knowledge and mostly just pursues the knowledge aspect and excludes the scientific ability of the students. So that mostly on learning process students just sitting, listening, and taking notes about knowledge that gave to them, and of course these situation can make students become activeless in the class and the impact from the learning process becomes bored [1,2].

Based on problems before, many demands are needed to make learning process to be success. So that it needs a model and strategy that is expected to create or explore scientific ability of students, that
not just from education at the elementary level and high school level, but Also education at the college level especially for science teacher candidates in the future [3].

This research has been done by using a Physics Textbook that has made by Suastika and Hartanto 2016 [4], referring to Laboratory Based Education based on inquiri process [5]. Samples of this research are students of Chemistry Education Study Program, University of Palangka Raya. This study aims to explore the scientific ability of students in the process of basic physics courses. The scientific ability that is expected in this case is an ability to understand the procedures, process, and methods that scientist use when constructing knowledge and when solving experimental problems, so that in the step by step students can do to constructing arguments about something new and they can provide a rational explanation from experiment [4,6,7]. samples (students) are divided into three categories of group those are excellent group, low group, and heterogeneous group. The result shows that the excellent group and low group have same case that were occured decreasing in the percentage of achievement of scientific ability, while in heterogeneous group was increased. The differentiation of these results are caused by enthusiastic level of students in every group that can be seen in scientific ability achievement aspects. By the results of this research, hoping in the future can be a references for further research about innovative learning strategies and models that can improve scientific ability and scientific reasoning especially for science teacher candidates.

2. Experimental Method
This research is a research that using a Physics Textbook that has made by Suastika and Hartanto (2016) [3], referring to Laboratory Based Education based on inquiri process. Samples of this research are students of Chemistry Education Study Program, University of Palangka Raya who was taking lesson of basic physic course. This research is a quantitative research by using descriptive method (descriptive-quantitative) that in the data analyzing using amount of size or frequency. All students are divided into some groups that consist maximum 5 students per group. In the division of groups, there will be three categories of group, first category is a group that has students with high academic ability (excellent group), second category is a group that has students with low academic ability (low group), and third category is a group that has heterogeneous academic ability (heterogeneous group). The division of these groups based from their middle test result.

In this research students will be given a laboratory activities (already listed in textbooks that have been distributed to each student) whose scientific ability is divided into 7 aspects of ability. Students' scientific ability data is collected through laboratory instruments that provided a scores according to scoring rubric [6]. Data result will be analyzed to determine the scientific ability using equation below [8].

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\% \text{ scientific ability} = \frac{\text{average score}}{\text{maximum score}} \times 100\%
\]

The laboratory activities are carried out twice on topic Ohm’s Law and Direct Current Circuit.

| Scientific Ability | explanation |
|--------------------|-------------|
| SA1                | Is able to design a reliable experiment that investigates phenomenon |
| SA2                | Is able to identify the hypothesis to be tested |
| SA3                | Is able to decide the physical quantities that are measured identify independent and dependent variables |
| SA4                | Is able to use available equipment to make measurement |
| SA5                | Is able to identify a pattern of data |
| SA6                | Is able to make a judgment about the results of the experiment |
| SA7                | Is able to identify the weakness of experiment and suggest an improvements |
Table 2. Scoring criteria [6]

| Score | Explanation          |
|-------|----------------------|
| 0     | Missing              |
| 1     | Inadequate           |
| 2     | Needs Improvement    |
| 3     | Adequate             |

3. Result and Discussion

The scientific ability that want to explored in this research is a basic skill that must be possessed by students in basic physics courses as part of a scientific method. In exploring the scientific ability, a science teacher candidates must be able to present the results of laboratory work and communicate it with others in their respective groups through scientific argumentation. Based on Constantinidou and Macagno (2013) and Lei Bao et al. (2009) that students who receive science learning must be able to present an accurate statements, communicate with others students in confidence, respond to other people's arguments and compare logical arguments. Scientific argument has a role to present and resolve the gap between ideas and evidence through valid statements [9, 10]. In addition, Berland and Hammer (2012) sad that a person has the ability to argue through its achievements in understanding the phenomenon that was experienced, communicate its understanding and convince others to accept its ideas [11]. The profile of scientific ability of chemistry education students University of Palangka Raya is shown in Table 3.

Table 3. Scientific ability of over all activities

| Group category   | Average score | % percentage of achievement |
|------------------|---------------|------------------------------|
| Excellent group  | 2.25          | 75%                          |
| Heterogeneous group | 2.07      | 69%                          |
| Low group        | 2.22          | 74%                          |

Table 3 describes the scientific ability in different categories of groups. It was found that the excellent group has the higher average score criteria that is 2.25 (from the maximum score 3) with the percentage of achievement is 75%. The low group has average score slightly below excellent group with a score of 2.22 with the percentage of achievement is 74%. While for the heterogeneous group has the lower average score of 2.07 with the percentage of achievement is 69%. Based on these results, it is interesting cases if we look at the percentage of achievement of the low group is higher than the Heterogeneous group. From this case, researcher found that although at the low group is consisted of students that have academic test value included to low category score, it does not ensure that their scientific ability is low, but instead have a scientific ability that can compete with heterogeneous group.

Table 4. Scientific ability for each group category in two different topics

| Group category  | Scientific ability | Ohm’s Law | % percentage of achievement | Direct Current Circuit | Average score | % percentage of achievement |
|-----------------|--------------------|-----------|-----------------------------|------------------------|---------------|------------------------------|
| Excellent group |                    | 2.37      | 80,9%                       |                        | 2.14          | 71,42%                       |
| Heterogeneous group |              | 2.06      | 68,57%                      |                        | 2.08          | 69,52%                       |
| Low group       |                    | 2.51      | 83,80%                      |                        | 1.94          | 64,76%                       |
Table 4 describes scores criteria of scientific ability for each group and their percentage of achievements for 2 topics that has been given in to different day, these topics are Ohm’s Law and Direct Current Circuits. From the result, it can be seen that the low group has an average score of 2.51 and percentage of achievement 83% on the topic of Ohm’s Law which has the highest achievement percentage than other groups. However, at the next lesson on the topic of Direct Current Circuit was occured drastically decrease of the score that is 1.94 and the percentage of achievement 64.76%. Based on these results, it is interesting cases if we look at the first lesson they were very enthusiastic in conducting the experiments so that at the beginning of the lesson on topic Ohm’s Law they got a good achievement proven with the data shown in Table 5. But in the second lesson on topic Direct Current Circuit that has been given in different day was occured decreasing of score criteria in their scientific ability. Of course from this result many speculations are created the reason why it decreased. However, the speculation can be seen clearly as shown in Table 6. Based on 7 important aspects of scientific ability, the low group has decreased drastically in almost of all aspects except in the aspect SA 4 which is in to use available equipment to make measurement, this is shown in Table 5 and Table 6.

In addition, Table 4 also describes that excellent group has average score and percentage of its achievement also decreased just like low group category. The decreasing occurs in almost of all aspects except in the aspect SA 7 which is in to identifies the weakness of experiment and suggest an improvements, this is shown in Table 5 and Table 6.

There is something more interesting case than the previous two groups before, it is heterogeneous group category. Although Table 3 shows that overall ability in both average and percentage achievement scores heterogeneous group has lowest value, but the average score and percentage of achievement were increased at the next lesson on topic Direct Current Circuit (see Table 4). This result indicated that their enthusiastic level were increased and exploring process of their scientific ability and scientific reasoning goes well. From this result, although heterogeneous group shows an increase in percentage achievement of scientific ability, but there is still some aspects that have decreased, these are in the aspect SA 1, SA 3, and SA 6.

**Table 5. Scientific ability for each aspect on topic Ohm’s Law**

| Scientific ability | Excellent group | Heterogeneous group | Low group |
|--------------------|-----------------|---------------------|-----------|
|                    | Average score   | % percentage of achievement | Average score   | % percentage of achievement | Average score   | % percentage of achievement |
| SA1                | 2.4             | 80                  | 2.4        | 80                          | 2.8            | 93.33                       |
| SA2                | 2.8             | 93.33               | 2.2        | 73.33                       | 2.2            | 73.33                       |
| SA3                | 2.2             | 73.33               | 2.4        | 80                          | 2.4            | 80                          |
| SA4                | 2.4             | 80                  | 1.8        | 60                          | 2.6            | 86.67                       |
| SA5                | 2.2             | 73.33               | 1.6        | 53.33                       | 2.4            | 80                          |
| SA6                | 2.4             | 80                  | 2.2        | 73.33                       | 2.6            | 86.67                       |
| SA7                | 2.2             | 73.33               | 1.8        | 60                          | 2.6            | 86.67                       |

**Table 6. Scientific ability for each aspect on topic Direct Current Circuit**

| Scientific ability | Excellent group | Heterogeneous group | Low group |
|--------------------|-----------------|---------------------|-----------|
|                    | Average score   | % percentage of achievement | Average score   | % percentage of achievement | Average score   | % percentage of achievement |
| SA1                | 2.2             | 73.33               | 2         | 66.67                       | 2.4            | 80                          |
| SA2                | 2.4             | 80                  | 2.4        | 80                          | 1.6            | 53.33                       |
| SA3                | 2               | 66.67               | 2.2        | 73.33                       | 1.8            | 60                          |
| SA4                | 2.4             | 80                  | 2.4        | 80                          | 2.6            | 86.67                       |
Table 6. Cont.

| SA5 | 1.8 | 60 | 1.6 | 53.33 | 1.8 | 60 |
|-----|-----|----|-----|-------|----|----|
| SA6 | 1.8 | 60 | 2   | 66.67 | 1.8 | 60 |
| SA7 | 2.4 | 80 | 2   | 66.67 | 1.6 | 53.33 |

4. Conclusion

Based on the results of this research, it has been found that the excellent group has the greatest of achievement percentage in exploring process of scientific ability, followed by the low group, while the Heterogeneous group has the lowest of achievement percentage in exploring process of scientific ability. However, if we look at the percentage of achievement scientific ability for the first and second lesson, the excellent group and low group have same situation that are occurs decreasing in the percentage of achievement, but the low group occurs drastically decreased compared to the excellent group. Unlike the case of heterogeneous group that occurs increasing percentage of achievement of scientific ability. The differentiation of these results are caused by enthusiastic level of students in every group that can be seen in tables of scientific ability achievement aspects. Based on these result, it further reinforces the conclusion that heterogeneous group are better than homogeneous groups. By the results of this research, hoping in the future can be a references for further research about innovative learning strategies and models that can improve scientific ability and scientific reasoning especially for science teacher candidates.

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