Profile of High School Students’ Understanding of Scientific Inquiry

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Abstract. Scientific inquiry is the main objective of education. The purpose of this study is to investigate the understanding of scientific inquiry from high school students in grade 11. This study has involved 32 high school students. The scientific inquiry understanding is measure by using VASI (Views About Scientific Inquiry) questionnaire. Then, all responses are categorized as informed, partially informed, and naïve. The result showed group of respondents have a comprehension in informed category at the relationship among procedures and research questions. In the other side, there are some group of respondents that still have lack comprehension in the aspect of characteristic scientific research and the relation between questions. There’s group of respondents still didn’t comprehend about the differences between scientific evidence and scientific data’s, the reason to select procedures, and also the relation between conclusion and data’s collection.

1. Introduction
Science education has important role to establish the students with some meaningful skills such as critical thinking, creative, logic and initiative in response to the society issues. The science educators in the whole world emphasize the importance of the nature of knowledge and scientific study as basic component and essential from science literate [1]. Furthermore, explained that scientific inquiry is become main curriculum standard in some countries. Scientific inquiry referred to various ways about how scientist study about the nature and formulate the explanations based on the evidence acquired from they research. Inquiry also referred to the student’s activity about how they can develop their knowledge and their point of view from scientific ideas, and also how scientist study about the nature [2].

This is very important to engage the students in each activity that involve thinking skill and intervened as a scientist [3]. Inquiry also includes students activities to evolved knowledge and comprehend some
scientific ideas, also for understand about how scientist work in study about the nature [4;5]. Scientific inquiry described as a process to do work and produce the knowledge from the scientist [6]. Scientific inquiry includes the methodology of knowledge and integrate with scientific knowledge, scientific reasoning and critical thinking [7]. Biology as one area of science subject has four aims, such as: teaching some Biology facts, evolving the skills, teaching the skills and encourage the tangible attitude [8].

Scientific inquiry refers to the ways which scientist do some research about nature and proposed explanation based on the evidence form what they did [9]. The study about point of view from the students as Biology teacher prospective and Science teachers regarding scientific inquiry has indicates understanding of the students as Biology teacher prospective are better than Science teachers in some scientific inquiry aspect and group of respondents still have less understanding or included in partial informed category at some scientific inquiry aspects [9]. Besides that, in the other study about the nature of science and scientific inquiry has indicates teachers and students have in view which not including in informed category [10;11]. According to the study result before and because of still slightly the research about scientific inquiry, it’s needed the research in purpose for describe the scientific inquiry from high school students.

2. Method
This study is using descriptive research which explore the understanding of high school students about the scientific inquiry. The subjects in this study are 32 high school students in science program grade 11 at SMA Negeri 1 Singaparna. The instrument use in this study for explore understanding about scientific inquiry is Views About Scientific Inquiry (VASI) developed by Lederman, et al (2014). Some important things about this instruments as the following: 1) question number 1, in the research instrument will give a scientific research case as descriptive research; 2) question number 5, respondent will give a task for choosing design that explained in discourse according on the question. The answer from this question is design A much better (> ) than design B; 3) question number 6, presented the data from the research with a deviant data. A task for respondent is for create a conclusion and the reason why they choose that conclusion; 4) question number 7, respondent has a task to choose the result reconstruction fossil and try to explain the reason also asked the information required to explained their choose. All the answers from the respondents will analyse and represented by three categories, which is: informed, partially informed, and naïve [6] and then making percentage. The categories will analyse from the reason given after respondents find the answers or choose the answers. The informed category if the answers relate with the view science constructivist, the partially informed if the answers relate with the view science constructivist about science but there are less for some stuff, the naïve category if the answers doesn’t relate with the view of science constructivist.

3. Result and Discussion
The results are summarized at table 1. Table 1 shows the percentage of results from the student respondents about scientific inquiry based on each category. Data is presented as a percentage of each category to make it easier to see comparisons between the three categories.
Table 1. Percentage students’ understanding of scientific inquiry

| No | Aspect of scientific Inquiry | Informed | Partially informed | Naïve |
|----|-----------------------------|----------|--------------------|-------|
| 1  | Is that investigation scientific? | 43.75 %  | 53.13 %            | 3.12 % |
|    | Is that investigation an experiment? | 31.25 %  | 9.38 %             | 59.38 % |
|    | Is scientific investigation can follow more than one method? | 18.75 %  | 62.5 %             | 18.75 % |
| 2  | Is scientific investigation always begins with scientific question? | 25 %     | 68.75 %            | 6.25 % |
| 3  | If question and procedure are the same, are scientists reaching the same conclusion? | 59.38 %  | 12.5 %             | 28.12 % |
|    | If questions are the same but procedures different, whether scientists reach the same conclusions? | 59.38 %  | 31.25 %            | 9.38 % |
| 4  | Are scientific data same with scientific evidence? | 3.12 %   | 21.88 %            | 75 %   |
| 5  | Questions guide procedure. A better than B | 15.62 %  | 37.5 %             | 48.88 % |
| 6  | Conclusions must consistent with data collected | 34.38 %  | 28.12 %            | 37.5 % |
| 7  | Best construction | 53.13 %  | 34.38 %            | 12.5 % |
|    | Information needed | 21.88 %  | 18.75 %            | 59.38 % |

3.1. Scientific investigation

For the first question are consists of three questions, is that investigation scientific? is that investigation an experiment? Is scientific investigation can follow more than one method?. Based on table 1. For the question is that investigation is scientific? Categorization of respondents pertained partially informed that is equal to 53.13%. Most students answer "yes" that the investigation (discourse in question) is scientific, but gives an unfavourable reason. This shows that respondents do not yet know the full characteristics and characteristics of an immoral activity. Although they have experience in conducting scientific investigations but little increase the understanding of the nature and process of science [12] The reason given by the students is that the person is conducting the research because of researching the bird based on the food, it is seen that the students' understanding is not yet intact. The next question relates to the student experimental research included in the naïve category, based on table 1. The percentage of 59.38% of the reasons presented is that he experimented because he could find the causal relationship of the research and the hypothesis. This shows that students have not understood the kinds of research. In general, research investigation has three types: descriptive, experimental and correlational [13]. For questions relating to various methods in the investigation of students included in the category of partially informed that is equal to 62.5% and a balanced percentage between students who include informed and naïve category that is equal to 18.75%.

3.2. Scientific investigation begins with question

To the next question whether scientific inquiry always begin with a scientific question? Categorization of respondents is partially informed that is equal to 68.75%. These results indicate that students are less
aware of the function of the question in an investigation. An inquiry begins with a question and a question will direct the investigation procedure [6]. With the question in the research it will show the purpose of research and can guide the research procedure so as to generate a conclusion. Given the importance of the questions in a study, the questions in the research must be formulated clearly so that research can be directed and generate data in accordance with the questions we formulate.

3.3. Procedures and conclusion

To the question whether scientists will get a same conclusion if they have same questions and same procedure? 59.38% of students respond according to the informed category. The reasons they have for the most part have understood that there are differences of conclusions even though the procedures and questions are the same or different. Among the reasons that they say most answer that everyone must be different thinking then the conclusion will be different. In other words the procedure will affect the results [6].

3.4. Procedure inquiry guided by question

To evaluate respondents’ understanding about relation between procedure and research question, respondents asked to choose one of two design A or B that agree with research question and they asked to explain their reasons. A total of 48.88% of students answered less precisely and fall into the naïve category. Of the appropriate answers were only about 15.62% of students who are able to provide reasons including informed categories, and about 37.5% of students who still have an understanding that belongs to the category of partially informed. To answer the same question, the scientist may design different procedures [6].

3.5. Scientific data and scientific evidence

For the question whether the data and scientific evidence are different? Respondents provided answers that belonged to the naïve category. The answer they put forward still confuses the difference between the evidence and the scientific data, although student answers state mostly that the evidence with the scientific data is different. Based on table 1. The percentage of naïve reached 75% almost as much as the number of students. In fact, the data is the result of observations collected by scientists during the investigation. The evidence is the result of data analysis that is interpreted and directly related to the specific question [6].

3.6. Conclusion must consistent with data collected

The respondent understanding of the relationship between the conclusions and the data collected, respondents were given a chassis about the duration of lighting at the rate of plant growth. Based on table 1 between the three categories yielding balanced respondents’ answers. The naïve category ranged from 37.5% while the informed respondents were 28.12% and the informed category was 34.38%. Judging from the answers presented by students most of the students answered in accordance with the data presented they make the appropriate conclusions based on the table. Each research conclusion should be supported by evidence derived from data collected [6].

3.7. Explanation developed of combination data collected and previous information

For the last question about relationship between investigation results and information were needed to support their finding, all respondent exactly chose conclusion and the best structure of possible Dinosaurus fossil. Most respondents chose the correct arrangement and referred to the drawings so that the informed category of 53.13%, but for reasons of information used by scientists to provide explanation...
only slightly touched the previous information so that included in the category of naïve with a percentage of 59, 38%.

4. Conclusion
In general group of respondents have the understanding in informed category on the relationship between procedure and study questions aspect. But there are still a lot group of respondents have less understanding on aspect of the characteristics scientific investigations and relation between questions. Group of respondents also still don’t understand about the differences between scientific evidence and scientific data, the reason choose procedure and the relation between conclusion and collection data. According to the finding from this study, the suggestion given to investigate another study towards difference subject for example to physic or chemistry subject.

References
[1] Senler B 2015 Middle School Students’ View of Science Inquiry: An International Comparative Study Science Education International. 26 166-179
[2] NRC 1996 Inquiry and the National Science Education Standards Washington DC: National Academy Press
[3] Ozgelen, S., Yilmaz-Turzun, O., & Hanuscin, D. L 2012 Exploring the development of preservice science teacher’ view on the nature of science in inquiry-based laboratory instruction. Researchin Science Education. 43 1551-1570
[4] Anderson, R. D 2002 Reforming Science Teaching: What Research Says About Inquiry? Journal of Science Teacher Education. 13 1-12
[5] Colburn, A. 2000 An Inquiry Primer. Science Scope. (March 2000), 42-44.
[6] Lederman, J.S., Lederman, N.G., Bartos, S.A., Bartels, S.L. Meyer, A. A., & Schwartz, R. S 2014 Meaningful Assessment of Learners’ Understanding about Scientific Inquiry-The Views About Scientific Inquiry (VASI) Questionaire. Journal of Research in Science Teaching 51 65-83
[7] Lederman, N.G. 2006. “Research on Nature of Science: Reflections on the Past, Anticipations of the Future”. Asia-Pasific Forum Science Learning and Teaching. 7 (1)
[8] Rustaman, N. 2003 Kemampuan Dasar Bekerja Ilmiah dalam Sains. Makalah Seminar, Bandung: Universitas Pasundan
[9] Adisendjaja, Y. H., Rustaman, N., Redjeki, S., Sator, D. 2016. Gambaran Pandangan Mahasiswa Calon Guru Biologi dan Guru IPA tentang Inkuiri Ilmiah. [Online] Tidak diterbitkan
[10] Lederman, J. S. & Lederman, N. G. 2004 Early Elementary Students’ and Teachers’ Understanding of Nature of Science and Scientific Inquiry: Lesson Learned From Project ICAN. Paper Presented at the Annual Meeting of the National Association for Research in Science Teaching. Vancouver, British Columbia. April, 2004.
[11] Schwartz, R.S., Lederman, N., Khishfe, R., Lederman, J.S., Mathews, L., & Liu,S. 2002 Explicit/Reflective Instructional Attention to Nature of Science and Scientific Inquiry: Impact on Student Learning. Paper Presented at The 2002 Annual International Conference of The Association for The Education of Teachers in Science
[12] Schwartz, R.S., Lederman, N.G. & Crawford, B.A., 2004. Developing Views of Nature of Science in an Authentic Context: An Explicit Approach to Bridging the Gap between Nature of Science and Scientific Inquiry. Science Teacher Education 88 610-645
[13] Lederman, J. S., 2009. Teaching Scientific Inquiry: Exploration, Directed, Guided and Open Ended Levels. In National geographic science: Best Practice and Research Base 8-20. Hapton Brown Publisher