Analyzing senior high school students’ view of nature of science and technology (VNOST)

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Abstract. The objective of this study was to analyze senior high school students’ view of Nature of Science and Technology. There were 25 senior high school students participated in this study. The instruments used to collect data was a VNOST questionnaire consisting of eight multiple-choice questions. The questionnaire covered four aspects of VNOST, namely the definitions, epistemology, internal and external sociology of science and technology. Students’ responses were analyzed using a frequency distribution for the characterization of students’ view trends. The results showed that most of the students’ answers belonged to the Has Merit category, which was 46.5% but there were still few students who had a realistic view of 30% and 23.5% of the students’ answers still included the Naïve category. This study shows that generally senior high school students did not yet employ a proper view of the nature of science and technology.

1. Introduction
Science teaching is not only related to teaching scientific events, abstract or theoretical objects or concepts but also developing knowledge through why and how investigations are related to scientific facts [1-3]. Students must have a good understanding of the nature of science or the Nature of Science (NOS) [4]. NOS covers epistemology of science, this includes science as a way of knowing, values that related to acquisition of new knowledge and beliefs that are inherent in the development of science [5]. NOS mastery will not be perfect without involving the technological aspect (Nature of Technology, NOT) in science learning at school. This is based on the many influences on the use of technology in society, for example, changes in the way of communication, pollution to global warming [6-8].

An understanding of the nature of science has been considered important for achieving scientific literacy [9]. The nature of science and technology (NOST) refers to an understanding of the role of specific construction and important features in the process of building science and technology. NOST can also be interpreted as process characteristics and products of scientists and engineers, including potential values of products [10]. An understanding of the nature of science and technology helps students to develop scientific inquiry skills and technology design and their metacognition so that they can be more effective in their work and become competent decision makers in the future [10].

2. Methods
The participants consisted of 25 high school students who were 11th-grade students of MIA. Data for this study were collected from a questionnaire that was selected and modified in terms of structure and format for Views on Science-Technology-Society (VOSTS) and has been proven valid [11]. The questionnaire consists of 8 multiple-choice items, which cover: definitions of science and technology, epistemology (scientific models of natural classification schemes), external sociology of science (reciprocal interactions with science, technology, and society), and sociology internal science (scientific decisions and technological decisions) [11,12]. Before use, the questionnaire was translated into English and validated by experts. To discuss the views of students on VNOST each stem question is grouped based on 3 categories that have been determined by [13], namely:
1. Realistic/R: the choice reveals the appropriate view.
2. Has Merit/HM: choices are not realistic, but reveal legitimate things.
3. Naïve/N: the choice of expressing the wrong/invalid thing.

The calculated VNOST student questionnaire data is the proportion of responses given by students using the equation:

$$ p = \frac{x}{N} \times 100\% $$

Explanation:

$p$: The proportion of a particular response
$x$: The number of students who gave a specific response
$N$: The number of students given questionnaires [14].

3. Result and Discussion
The student’s views on the nature of science and technology are presented in Table 1. These results indicate that generally scattered views from the Naïve, Has Merit and Realistic perspectives in all statements.

| Aspects of nst | VNOST Questionnaire Statements | Student view’s (%) |
|----------------|--------------------------------|--------------------|
| Definitions of science and technology epistemology of science | Science is…. | 28 | 68 | 4 |
| | Technology is…. | 16 | 84 | 0 |
| | The relationship between science and technology is…. | 32 | 56 | 12 |
| | Many scientific models (for example models of an atom) has characteristic…. | 24 | 28 | 48 |
| | Scientists classify something (for example elements in the periodic table) according to…. | 44 | 4 | 52 |
| internal sociology of science | How do scientists decide that a theory or model in science is acceptable or not? | 32 | 48 | 20 |
| | When a new technology is developed, it may or may not be put into practice. The decision to use new technology depends on…. | 44 | 48 | 8 |
| internal sociology of science | The relationship between science, technology, and society is…. | 20 | 36 | 44 |

3.1 A view of aspects of the definition of science and technology
Three sub-aspects in the definition of science and technology, namely, the definition of science, the definition of technology and the relationship between science and technology. There are still students who have a Naïve view of the definition of science, which is equal to 4% of students who express things that are not right about the real science concept. Meanwhile, there are many students who have Has
Merit views (choices are not realist, but reveal legitimate things) as many as 68% of students have the correct view of science as a body of knowledge that explains the world around us. However, 28% of students have a Realistic view, i.e. science is investigating the unknown, the discovery of new things and that science involves experiments to solve problems. Both views are appropriate because science actually unites processes and products of science, so science can be defined as the process of building scientific knowledge [15,16].

For sub-aspects of technology definition, no student has a Naïve view, 84% of students have Has Merit views, some students have the view that technology is a variety of human-made objects such as devices, scientific instruments, and instruments (eg computers). Some other students viewed technology as the application of science for improving the quality of life. The concept of technology is not only related to devices as technology products but also related to knowledge about their use, applications, and processes in developing products [17,18]. As many as 16% of students already have a realist view of technology definition, they have the view that technology creates, designs, develops and tests scientific devices, tools and instruments, and processes to produce and know how to make things.

Related to the sub-aspects of science and technology relations, there are still students who have Naïve views as much as 12%. These students do not understand the relationship between science and technology. 32% of students have Has Merit views, where they have the view that science is the basis of technology, but difficult to see how technology affects science. Most students (56%) have an appropriate view of the relationship between science and technology. These students believe that scientific research leading to practical applications, on the other hand technological developments may in return enhance the ability to conduct scientific research. The relation between science and technology is often described as a two-way interaction in which both are closely related and contribute to each other [19,20].

3.2 A view of the epistemological aspects of science

There are two sub-aspects related to the epistemology of science-namely, the nature of the scientific model and the nature of the classification scheme. Nearly half of the students, 48% of them have inappropriate views regarding the nature of scientific models, most students do not have an understanding of the scientific model. In addition, 28% of students have the view that the scientific model approaches the original object because it is based on scientific observations and investigations and that view belongs to Has Merit. Meanwhile, 24% of students have a corresponding view regarding the scientific model which is related to the understanding that the scientific model is not the same as the original object because the model is only used to help explain something with all its limitations.

Regarding the sub-aspects of the nature of the classification scheme, more than half the number of students have a Naïve view, namely, 52% of students do not have an understanding regarding the classification scheme. Meanwhile, 4% of students have Has Merit’s view by assuming that the classification scheme is a scientist classifying things in a simple and logical way, but that does not mean that it is the only way. And 44% of students have appropriate views regarding the classification scheme, most of them have the view that there are many ways to classify things, but one universal system must be agreed upon so as not to cause confusion.

3.3 A view of the aspects of internal sociology of science

There are two sub-aspects related to internal sociology of science namely, scientific decisions and technological decisions. There are still students who have a Naïve view that is as much as 20% of students do not have an understanding related to scientific decisions, and almost half of the students, 48% of students have Has Merit views, where they have the view that scientific decisions are scientifically based on observed facts. Meanwhile, 32% of students have a realist view of scientific decisions, most of them have the opinion that the scientist’s decision is based on whether the theory has been tested many times and no one has broken it.

3.4 A view of the aspects of external sociology of science
The sub-aspects of external sociology of science are related to the relationship of science, technology, and society, almost half of the students have a Naïve view of 23.5%. Most of them considered science, technology, and society are not related. Meanwhile, 36% of students have Has Merit's view that they argue that science and technology often make our lives healthier, easier, and more comfortable. Few students have a realist view (20%) arguing that a nation progress depends heavily on the development of science and technology.

4. Conclusion
The results of the study show that in general the views of high school students about the nature of science and technology are still inappropriate and shallow. In all aspects of NOST Most students expressed a Naïve viewpoint of 23.5%, Has Merit which was 46% and realistic 30%.

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