The profile of students' views of nature of science (NOS) in Junior High School of Yogyakarta City

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The Profile of Students' Views of Nature of Science (NOS) in Junior High School of Yogyakarta City

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Abstract. Scientific literacy has become a contentious issue for the science education community, and It has been the main goal of science education reform in various countries in this century. One of the vital components in science literacy is the understanding of Nature of Science (NOS). This research report about the profile of junior high school students' views of Nature of Science (NoS). It was employed by descriptive survey research design. The participants were 186 students of 8th in the academic year 2017-2018. Purposive sampling techniques were performed to select the junior high school as participants. The students were from six schools that were divided into three groups depending on the favorite level of junior high school based on the interest of registrant, the input (the value of accepting new students) and the output (the value of National Examination) they had. They were divided into high, medium, and low level based on the favorite rank of school. The instrument for collecting data was questionnaire of NOS. Descriptive quantitative and inferential statistic were employed to analyses of the data. The results indicated that most of the students in junior high school in Yogyakarta had good category for attitude, very less (poor) understanding for the process, and less understanding for product aspects of NOS. There is a strong relationship between the understanding of NOS and the school favorite rank.

INTRODUCTION

Scientific literacy has become a contentious issue for the science education community, and It has been the main goal of science education reform in various countries in this century. One of the vital components in science literacy is the understanding of Nature of Science (NOS). NOS is essential thing in the development of scientific literacy [1]. Of course, the understanding of NOS should be emphasized to be adequately controlled in the students themselves. As of today there are many world educational/science curriculum aims to help students gain an adequate understanding of NOS (Nature of Science).

There are various definitions that describe NOS, but the NOS definitions that apply universally have not been agreed. NOS as the epistemology and sociology of science, science as a way of knowing, or the values and beliefs associated with scientific knowledge and its development [2]. NOS also defines the values and assumptions inherent in scientific knowledge and the development of scientific knowledge [3]. A comprehensive definition is proposed by McComas as follows.

> The nature of science is a fertile hybrid arena which blends aspects of various social studies of science including the history, sociology, philosophy of science combined with research from cognitive sciences such as psychology into a rich description of what science is, how it works, how scientists operate as a social group and how society itself both directs and reacts to scientific endeavors. [4]

Rai (2012) argues that "One of the important outcomes underlined by almost all the definition of scientific literacy is the knowledge and understanding of epistemology of science, popularly known as NOS". [5]

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Nature of Science (NOS) is important because NOS understanding is essential to understand the objects and processes of science and technology in the daily life of our life management, to inform sociological decision-making issues, to appreciate the value of the axis as a contemporary cultural point and to grow an understanding of the norms of the scientific community that embody a common moral commitment to society. Clough defines "NOS is a commonly used phrase by science educators to indicate ideas about science--issues of what science is and is not, how science and scientists work, the ontological and epistemological foundations of science, and how science and society impact one another" [6].

NOS is emphasized as an important component of science literacy. Adequate NOS mastery is accepted as an expected student character and incorporated into a wide variety of curricula in the world at large. Drivers, Leach, Miller, and Scott suggest that NOS supports the inclusion of NOS as a goal in science learning because NOS improves learning of science content, understanding of science, interest in science, decision making on community issues related to science, and delivery learning science [7].

Much of the research on NOS understanding focused on elementary and high school teachers and students shows that students 'and teachers' understanding is often incongruent [8]. In this case, the understanding of NOS profile of junior high school students of Yogyakarta also means to illustrate how the understanding of science teachers of the junior high school. The reason for Yogyakarta city because the city of Yogyakarta is a city in Indonesia, which is known for the quality of good education.

Students scientific literacy development requires a complete picture of NOS understanding. Thus reason, it is important to examine how the understanding of junior high students be described and reviewed from the level of school based on the favorite rank. Data of this research is certainly useful to be an input in improving the orientation of science learning to optimize the development of science literacy students.

METHODS

This research was performed by using descriptive quantitative design. It is intended to make the description systematically, accurately, and in accordance to the reality of what to be the understanding of NOS in grade VIII students in the junior high school of Yogyakarta city viewed from the school's favorite rank.

The research location is 6 junior high schools from 16 junior high schools in Yogyakarta City, categorized into three school's favorite rank (high, medium, and low). Each categorization of favoritism is represented by two schools. The sixth selection of Junior High School is based on the interest of registrant, the input (the value of accepting new students) and the output (the value of National Examination) they had. The total number of samples taken was 186 students grade 8th, selected by purposive sampling technique, using the criteria of schools that have a minimum standard of junior high school's science laboratory facilities and the use of laboratories that are adequate for science learning. Description of the school as in Table 1.

TABLE 1. NAME OF SCHOOL AND ITS FAVORITE RANK

No.	School favorite rank	The label of junior high school	Sum of school
1.	High	School A	2
		School B	
2.	Medium	School C	2
		School D	
3.	Low	School E	2
		School F	

NOS student understanding data collected using NOS questionnaire was prepared based on NOS aspect division according to some experts i.e. Carin & Sund, Ledderman and Next Generation Science Standard (NGSS). Statements in the NOS questionnaire are 20 statements. Questionnaire NOS before use is tested empirically to be tested for its validity and reliability.

TABLE 2. THE INDICATORS OF NOS

No	Aspect of NOS	Sub Aspek NOS	Number of Item
1.	Process	Science is a collection of knowledge and investigation	1,13
		Scientific investigations are based on empirical Evidence	3,6
		Scientific investigations use a variety of methods	2, 8,16,12
		Human creativity is the need for developing of science	10,17
2.	Attitude	Scientific attitude consists of social and moral value	15,10,20
		Scientific attitude is the need for make decision after data collection	5
3.	Product	Scientific knowledge is the collection of knowledge more than one generation	9,14
		The scientific product is a fact, concept, generalization, principle, theory, and law	4,19
		Scientific knowledge is open to revision in light of new evidence	7,11,18

Analysis of validity and reliability of the Quest program. The test results of validity as Table 3

TABLE 3. UNDERSTANDING OF NOS INSTRUMENT VALIDITY TEST RESULTS

No	Compatibility with Rasch model	Mean	SD	Note
1.	*Infit mean square*	0.94	0.47	*Fit*
2.	*Outfit t*	-0.09	1.15	*Fit*

Table 3 shows that the results of empirical validity of 20 instruments of NOS understanding are declared valid because Infinite mean square and outfit t values meet the criteria in the Rasch model. The results of the NOS questionnaire reliability test show the internal consistency value of 0.84 with a very high category.

Each statement is given a score of 0 if false, 1 is true but not given a reason, score 2 if true but wrong reason, score 3 if the answer is correct but the reason is not accurate, and 4 if the answer is right and the reason is right. The total score is converted to a value with a maximum value of 100 and is subsequently interpreted using the following guidelines [9].

TABLE 4. CRITERIA INTERPRETATION OF UNDERSTANDING OF NOS

Interval	Criteria
86 – 100	Excellent
76 – 85	Good
60 – 75	Enough
55 – 59	Less
≤ 54	Very Less (Poor)

The data has tested the prerequisites using the Kolmogorov-Smirnov normality test. When the data were analysis found to be not normally distributed then analyzed data using Spearman for the correlation test.

RESULT AND DISCUSSION

Lederman, et.al.suggests that a crucial component for assessing NOS understanding as part of NOS research [10]. Many definitions explain the nature of science or NOS, but the NOS does not have an agreed universal definition [11]. However, the understanding of NOS of junior high school students in Indonesia has never been investigated, whereas the NOS students' understanding information is important to know. The students understanding of NOS information can illustrate students' difficulties in understanding science as well as its scientific method.

Young Oh states that key aspects of NOS should be seen in this study as interdependent, dynamic, explicit, and reflective [12]. Being empirical means that perception will provide objective facts about the world, on the basis of science and law and general theory generated inductively based on these facts. However, our perceptions are not objective. Judgments and inferences on facts that can be observed in specific situations will change depending on

the individual if the individual changes, depending on the culture if the culture changes. That is, in the social and cultural background in which the subject originated, the subject's perception was formed and developed in a decisive way by the observer's subjectivity and the theoretical and cultural backgrounds, expectations, and perspectives that the observer has (subjectivity). Such considerations are dealt with under the heading of observational theory in the philosophy of science. Thus, we insist that the law shows the regularity and theories that our creativity needs to be dynamic rather than separate, because of the theory-laden observation. That is, it is not a scientific method represented by induction. law or objective theory is not generated from objective facts means that scientific theory is indeed tentative. A new flow map based on the key aspects of NOS as Figure 1.

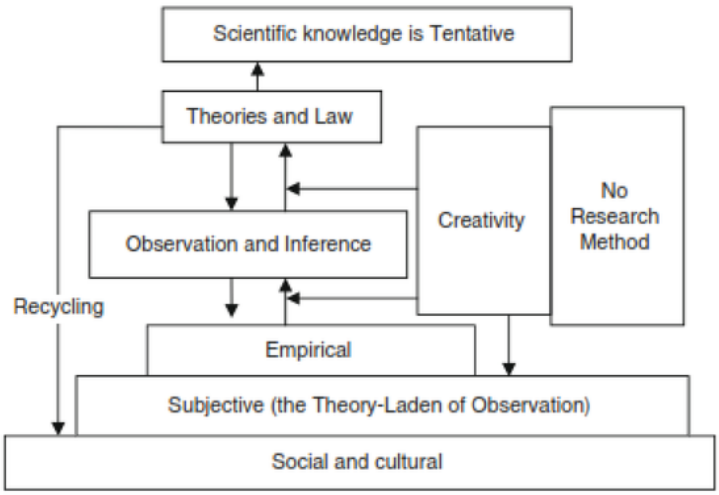

FIGURE 1. A NEW FLOW MAP BASED ON THE KEY ASPECTS OF THE NATURE OF SCIENCE OR NOS [12]

NOS is defined as the values and assumptions inherent in science, scientific knowledge, and the development of scientific knowledge. It shows the unique characteristics of science and explains what the nature of science is, how it works and how it differs from other disciplines, what scientists have done throughout history, and how science and scientists interact with society [13]. Based on the definitions of these experts, it can be understood that Nature of Science (NOS) is a characteristic of the science itself. There are three aspects of Nature of Science, include of the process, product, and attitude aspect.

NOS is included in Next Generation Science Standards [14]. As a result of these reform efforts, NOS has been designated as a permanent science education destination by many countries including Canada, the UK, and the United States and is under increasing pressure among researchers [15]. Turkey has also received NOS among science education visions in the national science curriculum since 2004. Krajewski & Schwartz argues that a shift in science learning orientation from product-oriented learning to process-oriented learning is essential for realizing NOS teaching [16]. The profile of the student about views of NOS in Indonesia, especially students in the junior high school of Yogyakarta City very important to describe in which category the aspect of NOS the student in junior high school based on the school favorite rank.

a. Students' Understanding of NOS based on School Favourite Rank

Here is the average understanding of NOS of 8th-grade students in the city of Yogyakarta in based on school favorite level.

TABLE 5. Mean of The Understanding Value of Nos Of Students Grade 8th Junior High School in Yogyakarta City Judging From The Favorite Rank of School

No	Favorite Rank of School	Max.	Mean	Category
1	High	100	61,26	Enough
2	Medium	100	25,74	Poor
3	Low	100	24,09	Poor

It is known that most students from schools with high priority levels have sufficient NOS understanding whereas most students from schools with moderate and low adversity have a relatively poor understanding of NOS. These results indicate that students from high school schools have a better understanding of NOS compared with medium and low category schools.

Here is an average histogram of students' understanding of each aspect of NOS, includes three aspects: processes, attitudes, and products.

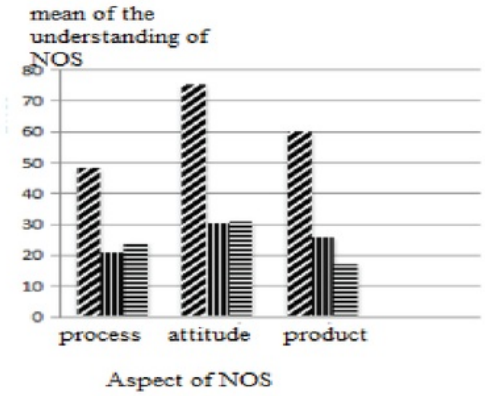

FIGURE 2. Average Histogram of Understanding Aspects of NOS of Students Grade 8TH in Junior High School in Yogyakarta City Based on Favorite Rank

Based on Figure 2 it can be seen that students from schools with high, moderate and low adventurous levels have the highest mean of attitude comprehension. Students from schools with high and moderate adversity have the lowest mean on understanding aspects of the process whereas students from low-level schools have the lowest average on the product aspect. Student understanding of NOS in junior high school still adequately apparently because the teacher understanding does not translate directly into science learning it is also obvious that teachers cannot effectively design and teach lessons about concepts they do not understand.

b. The Proportion of Student's Understanding of NOS in Each Category

Students' full understanding of each school category on NOS can be found in Table 6.

TABLE 6. UNDERSTANDING NOS GRADE VIII SMPN STUDENTS IN YOGYAKARTA CITY VIEWED FROM SCHOOL FAVOURITE LEVEL

No.	Category of understanding of NOS	The school favorite rank					
		High		Medium		Low	
		fo	fr (%)	fo	fr (%)	fo	fr (%)
1	Excellent	0	0	0	0	0	0
2	Good	10	16.13	1	1.61	0	0
3	Enough	30	48.39	1	1.61	0	0
4	Less	3	4.84	2	3.23	3	4.84
5	Poor	19	30.64	58	93.50	59	95.16

Note:
fo = objective frequency
fr = relative frequency

Table 5 shows that the NOS understanding of the majority of students from schools with a high degree of preference is good while the NOS understanding of the majority of students from schools with moderate and low to moderate adversity is poor. It is because the junior high school of Yogyakarta city have not been trained to do inquiry in science learning [17]. It makes the students cannot understand about process, product, and attitude well.

c *Students Understanding of each sub aspect NOS* based *on school favorite rank*

Data also show that students' understanding of high-grade school to sub-aspect of NOS (Nature of Science) is highest on tentative sub-aspect (75,8%) and lowest in sub-aspect. Scientific knowledge is derived from scientific data (44, 4%). The students' understanding of the medium category schools on the sub-aspect of NOS (Nature of Science) is the highest in the sub-aspect of scientific attitudes including values and morals (31.8%) and the lowest is on sub-aspect of creativity (18.4%). Understanding students from low-grade schools to sub-aspects of NOS (Nature of Science) is the highest in sub-aspects of scientific attitudes include values and morals (40.6%) and the lowest is on sub-aspects of scientific products (fact, law, theory) (23.9%). Based on A.Widowati [18], the science teacher still has the misconception about the understanding of NOS, and it can affect the student understanding of NOS too. For example, in the statement "the scientific knowledge is not open to revision in light of new evidence", there are 4 teachers from 10 teachers state true.

d. The relationship between the understanding of NOS and the school favorite rank

The result of the prerequisite test for normal distribution of data with Kolmogorov-Smirnov shows that the data has significant value 0.00, so it means the data doesn't distribute normally. So, the analysis of data is being continued by uses Spearman test for the correlation test. The result of Spearman test shows the Spearman's rho = 0.611. it means there is a strong relationship between the understanding of NOS and the school favorite rank. It is because school favorites are related to school quality. The good facilities of learning and good teacher quality as the several factors in school quality that can support the level understanding of NOS in junior high school student.

Based on all data of the student's profile of understanding of NOS, they describe that the students' understanding of NOS in the junior high school of Yogyakarta city still lack, so it must be optimal develop urgently. It is because the understanding of NOS important to present students with a more constructivist epistemology of science. With adequate understanding of NOS, the students can develop an understanding that scientists hold theories that underlie the generation and interpretation of specific hypotheses and experiments. We want them to understand that our knowledge of the order in nature is a consequence of successful conjecture, not its predecessor and that adequate theoretical perspective is essential for observation and experimentation. Thus, without challenging students' belief that theories can ultimately reflect reality, we may be able to help them see that the theory is a large-scale intellectual construction that is the understanding of scientists and guides the daily activities of scientists. Such an understanding will help students understand why scientists are experimenting, why there is a legitimate controversy in science, and even why learning science is hard to do. Based on data, we as the teacher must develop a strategy or models of teaching to develop the students understanding of NOS well.

CONCLUSION

Based on data analysis and the discussion got the following conclusion that understanding NOS students from schools with a high favorite rank on aspects of attitude quite good, the aspect of the process pertained very less and on aspects of the product classified as less. Understanding of NOS students from schools with moderate and low levels of ideality in aspects of processes, attitudes, and products is lacking. Most of the students in junior high school in Yogyakarta had the good category for attitude aspect of NOS, very less for process aspect of NOS, and less for product aspects. There is a strong relationship between the understanding of NOS and the school favorite rank.

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