

Correlation Amongst Understanding of NOS, Conceptual Understanding, and Science Process Skill of Undergraduate Students on General Chemistry

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Abstract. The aims of this research were to study the correlation between NOS Understanding and Conceptual Understanding and between NOS Understanding and Science Process Skills. This study also serves as an empirical validity test of the NOS understanding questionnaire that researchers have developed. This correlational research was carried out at the Faculty of Mathematics and Science Education of IKIP Mataram. Ex post facto method was employed in this study. The study involved 75 students taking General Chemistry course for the academic year of 2018-2019. The participants were selected by using the saturated sampling method. Data were collected using a NOS understanding questionnaire, concept understanding test, and observation sheet of science process skills. The data are presented descriptively. The correlation test was carried out by using product moment test. The results uncovered a strong and significant correlation between NOS Understanding and Conceptual Understanding and between NOS Understanding and Science Process Skills. The results of this study indicate that the NOS understanding questionnaire has been compiled can be used to measure the level of students' understanding of NOS and predict students' performance of science process skills and conceptual understanding in chemistry learning.

INTRODUCTION

As the goal of national education and the demands of the 2013 curriculum, chemistry learning in schools should be able to shape learners to be a problem-solver with a scientific character. Consequently, chemistry learning for prospective chemistry teachers must also encourage the formation of character as chemical scientists. Therefore, those prospective teachers should be taught through a strategy that encourages the improvement of science process skills [1]. According to [2], science process skills in learning science include the skills of observing, measuring, classifying, predicting, inferring, communicating, interpreting data, making operational definitions, making questions, composing hypotheses, experimenting and formulating a model. Comparing things that are observed which then develop into the ability to find similarities and differences. There is a significant correlation between science process skills and students learning achievement [3].

Students are natural conceptualizer. Students, as humans who always conceptualize at all times, comparing natural tendencies and distinguishing objects, events, all things. To take advantage of this natural tendency, effective learning environments must be put in place. That should give students assignments to increase their effectiveness in shaping and using concepts. Moreover, helping them become aware of developing skills for completing a task [4]. Guidelines for establishing an effective learning environment that is by helping students concentrate on something they understand and produce ideas. Effective learning environment help students to develop conceptual understanding of certain knowledge that force students converting conceptual understanding into the skills of developing categories, making algorithmic formulations, generating and testing hypotheses [5]. In addition, directing students to the acquisition of knowledge and understanding of concepts, and practice science process skills [6-8].

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According to [9], the achievement of students' performance in learning science in class can be pursued through focuses on the ability of the epistemology of science/nature of science (NOS). It is according to an understanding of the characteristics of science as a form of human knowledge and inquiry. Subjects in science learning that are delivered correctly can contribute to achieving the goals of learning [10]. The main purpose of integrating the Nature of Science (NOS) concepts into the science curriculum is to help educate students to solve complex science and technology problems in modern life and democratic culture. Establishing the Nature of Science (NOS) as a major component of the science curriculum is an important learning goal [11].

Nature of Science (NOS) refers to the epistemology of science, science as a way of knowing, or the values and beliefs inherent in the development of scientific/scientific knowledge [12]. Understanding of NOS is a characteristic that is expected to exist in someone who has scientific literacy. Through scientific literacy, the person is able to develop an understanding of concepts, principles, theories and processes of science, and realize the existence of complex relationships between science, technology, and society [13]. So, in principle, NOS includes the conception of scientific knowledge, values and beliefs in obtaining such scientific knowledge, as well as its influence on society, culture, and science technology. The level of students understanding of Nature of Science (NOS), students understanding of Nature of Science (NOS) correlation toward students science process skills and concept understanding, are an issue that still needs to be studied. The aims of this research were to study the correlation between NOS Understanding and conceptual understanding and between NOS understanding and science process skills. By comparing it with commonly used science process skill and conceptual understanding instruments, this study also serves as an empirical validity test of the NOS understanding questionnaire that researchers have compiled. So, this questionnaire can be used not only to assess students' understanding of nature of science but also to predict students' performance on science process skill and conceptual understanding in chemistry learning.

METHODS

This research aimed to study the correlation between understanding of NOS (Nature of Science), conceptual understanding and science process skill. This correlational research conducted with the ex-post-facto method and carried out at the Faculty of Mathematics and Science Education, IKIP Mataram. The subject was 75 students taking General Chemistry course on academic years of 2018/2019 which were selected by saturated sampling technique.

The data of this study consist of understanding of NOS, conceptual understanding, and science process skill. The data of understanding of NOS were collected by the understanding of NOS questionnaire. Conceptual understanding data were collected by using conceptual understanding test and science process skill data collected by science process skill observation sheet, both instruments are developed by [1].

This research was conducted according to the following procedures: (1) understanding of NOS questionnaire testing; (2) measuring understanding of NOS data; (3) applying treatment in general chemistry class; (4) observing science process skill and measuring conceptual understanding of research subject. Understanding of NOS questionnaire was tested validity and reliability of the instrument. The test was conducted on 84 students of IKIP Mataram. Instrument validity was analyzed using product-moment correlation and instrument reliability was analyzed with Alpha correlation test by three split technique [14]. Then, the data categorized by level categorization method based on the deviation standard [14]. Product moment correlation test is used [15] to examine the correlation between two variables. While correlation category based on correlation coefficient r_{xy} which are found by applying equation $r_{xy} = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$ [15]. Data analysis was carried out assisted with Ms. Office Excel 2010 for Windows.

RESULT AND DISCUSSION

Understanding of NOS Questionnaire

Understanding of NOS questionnaire consists of 39 valid items which are the predictor of 10 understanding of NOS aspect. Validity and reliability tested were carried out with 84 respondents involved. The reliability coefficient of understanding of NOS questionnaire about 0.802 is categorized as very high reliability. Developing nature of science questionnaire is very important toward valid and meaningful assessment of learners' conceptions of nature of science. Information that obtains through NOS concept assessment will directing teacher which aspect of understanding of NOS need improvement to boost students' performance on learning [12]. Items questionnaire distribution on each understanding of NOS aspects is showed in TABLE 1.

TABLE 1. Item questionnaire distribution of understanding of NOS

Aspect of NOS	Item number
Scientific knowledge is tentatively	3
Scientific knowledge comes from empirical data	3
Scientific knowledge as human inference product	3
Human creativity needed to develop knowledge	5
Scientific method	6
Knowledge is not detached from theory/ scientist understanding (Theory driven)	3
Scientific law	4
Scientific theory	5
Science social dimension	3
Science integrated on social and cultural fields	4
TOTAL	39

Description of Understanding of NOS, Conceptual Understanding, and Student Science Process Skill Description Data

Data description of students understanding of NOS, conceptual understanding and science process skill as presented in TABLE 2.

TABLE 2. Data description of students understanding of NOS, conceptual understanding and science process skill

	Understanding of NOS	Conceptual understanding	Science skill process
N	75	75	75
Highest score	73.85	90.00	87.00
Lowest score	58.97	60.00	50.00
Average	66.58	71.09	64.57
Varian	13.44	70.08	73.36
Deviation standard	3.67	8.37	8.56

TABLE 2 shows that the average of understanding of NOS, conceptual understanding and science process skill data are 66.58, 71.09 and 64.57. Comparing to these three variables, we can assess that conceptual understanding was the highest average and science process skill was the lowest average. Data distribution of students understanding of NOS, conceptual understanding and science process skill categorized to high, medium, and low as shown in TABLE 3.

TABLE 3. Categorization data of understanding of NOS, conceptual understanding and students' science process skill

Category	Understanding of NOS		Conceptual understanding		Science process skill	
	Range	Amount	Range	Amount	Range	Amount
High	70,26-100	17	79,47-100	18	73,15-100	11
Medium	62,92-70,25	47	62,72-79,46	41	56,01-73,14	51
Low	20-62,91	11	0-62,71	16	0-56,00	13
TOTAL		75		75		75

Percentage of understanding of NOS, conceptual understanding, and science process skill of student was shown at Fig. 1.

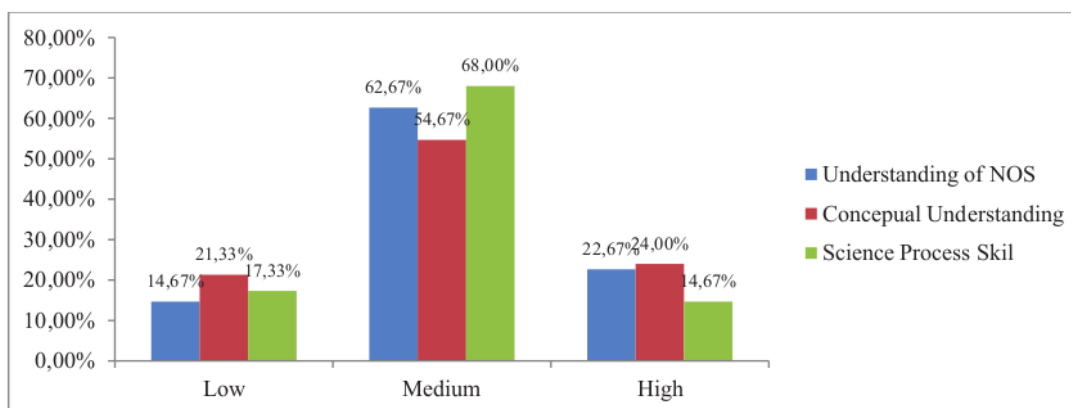


FIGURE 1. Percentage of students understanding of NOS, conceptual understanding and science process skill

According to TABLE 4 and Fig. 1, appear that most of the student has the medium category of understanding of NOS, conceptual understanding and science process skill as following 62.67%, 55% and 68%. Figure 1 also shows when a student has a high level of understanding of NOS, they also will have a high level of conceptual understanding and science process skill. This result also supported by correlation test amongst these three variables.

Correlation Amongst Understanding of NOS, Conceptual Understanding and Science Process Skill

Correlation test amongst understanding of NOS, conceptual understanding and science process skill are summarized in TABLE 4.

TABLE 4. Summary of correlation test amongst understanding of NOS, conceptual understanding and science process skill

Variable 1	Variable 2	r	$r_{table} (N = 75; p = 5 \%)$	Conclusion	r_{xy}	Conclusion
Understanding of NOS	Conceptual Understanding	0.380	0,227	Significant Correlation	0.994	Very Strong Correlation
	Science Process Skill	0.414		Significant Correlation		

The correlation amongst Understanding of NOS and Conceptual Understanding

Based on data analyzing the result, r_{count} value of the correlation between understanding of NOS and conceptual understanding is 0,38 that larger than r_{table} at significant level 5% (0.227), meaning that there is a significant correlation between students understanding of NOS and conceptual understanding. Then correlation coefficient (r_{xy}) is 0.994 meaning a very strong correlation between both variables. A very strong and positive correlation between understanding of NOS and conceptual understanding shows both variables have a parallel relationship meaning that if a student has a good understanding of NOS so they will have good conceptual understanding. It is very important to develop and enhance student conceptual understanding [16]. The objectives of science instruction at all level should be conceptual understanding and scientific inquiry [17]. Students with a good understanding of the nature of science will be able to direct themselves towards the discovery of concept on learning science process [18]. Good conceptual understanding lead to students success in science learning [19].

The correlation amongst Understanding of NOS and Science Process Skill

Based on data analysis, it found that r_{count} value of the correlation between understanding of NOS and science process skill is 0,414 that larger than r_{table} at significant level 5% (0.227). So that means there is a significant correlation between students understanding of NOS and science process skill. Then coefficient correlation (r_{xy}) is 0.993, means

there is a very strong correlation between student's understanding of NOS and science process skill. This result shows that a student has a good understanding of NOS so that they must have good science process skill.

Science process skills are special skills that simplify learning science, activate students, develop students' sense of responsibility in their own learning, increase the permanency of learning, as well as teach them the research methods. This skill is expected to be mastered apart from just being excelled in their academic performance [20]. It is more important for the students to learn how to apply science than learning reality, concepts, generalizations, theories and laws in science lessons. Therefore, it is necessary for them to pick up the habit of science process skills [21]. Understanding of the nature of science includes the concepts of scientific knowledge, values and beliefs in gaining scientific knowledge, as well as their effects on society, culture, and technology [22]. Therefore it is very important to develop students understanding of NOS so that students are aware of carrying out the scientific process and have excellent performance.

CONCLUSION

This study was fully carried out on general chemistry student at Faculty of Mathematics and Science Education of IKIP Mataram. Based on the study, it can be concluded that there is a significant and very strong correlation amongst understanding of NOS and conceptual understanding. There is a significant and very strong correlation amongst understanding of NOS and science process skill. Therefore, it can be stated that when a student has a better understanding of NOS than they will have better in an understanding of concept and science process skill. Due to the result, it is suggested to apply the learning process-oriented to the understanding of NOS in order to improve student conceptual understanding and their science process skill.

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