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Do understanding nature of science (nos) play role to students understanding chemistry concept and science process skill?

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Abstract. The aim of this research was to evaluate how Understanding Nature of Science (NOS) play role to students Understanding chemistry concept and Science Process Skills on Chemistry Classroom. This descriptive research was carried out by Ex-post Facto method at the Faculty of Mathematics and Science Education of IKIP Mataram. The research subjects were 75 students participating in the General Chemistry course for the academic year 2018-2019 that taken by the saturated sampling method. Data were collected by understanding of NOS questionnaire, Understanding chemistry concept Test, and Science Process Skills observation sheet. The data is described and analyzed by product moment correlation test and One Way Anova test for uncorrelated samples. The results showed that there was a significant and very strong correlation between Understanding of NOS and Understanding chemistry concept and between Understanding of NOS and Science Process Skills. One Way Anova test result showed that there was difference on Students Understanding chemistry concept and Science Processes Skills on different Understanding of NOS.

1. Introduction

Various breakthroughs in science and technology that spread throughout the world have increased the quality of life of human kind [1]. But these discoveries and developments are accompanied by the emergence of alarming problems such as global warming, pollution and the reduction of global energy resources. In order to overcome these problems, it is necessary for citizens who understand science concepts, are able to think critically, creatively, reasoningly, and care. It is they who can preserve the environment, health, and make decisions about social policies for themselves and their communities. This hope will be achieved if the community has scientific literacy [2].

The tendency of science education policy emphasizes the importance of scientific literacy as transferable outcomes in science education [3]. Building science literacy means focusing on building students' knowledge to use science concepts meaningfully, carrying out science processes, thinking critically and making balanced decisions on issues relevant to the lives of students in the social dimension of education and active participation in society [4]. Understanding concepts and applying science processes is an important learning experience in building students' scientific literacy. Besides that, in order to be able to build scientific literacy, students need to be equipped with an understanding of the nature of science which includes concepts about knowledge science, values and beliefs in acquiring scientific knowledge, and their influence on society, culture and technology [5].

In the view of constructivism, the process of gaining knowledge takes precedence over how much knowledge is gained and remembered. Students must actively participate and be responsible for learning [6]. Knowledge is always a construction process from someone. Objects and environment are only means for the construction process. Knowledge will be transferred only if the recipient can construct that knowledge. Several factors such as the limitations of previous construction experience, and a person's cognitive structure can limit the formation of the person's knowledge [7].

The knowledge in question is not limited to knowledge that is informative but mathematical-logical knowledge that directs the process of scientific thinking. Scientific thought is a continuous process of construction and reorganization. Through this process of scientific thinking one can obtain concepts and design problem solving. Both are knowledge, according to Piaget [7] knowledge is not something that exists outside but is in someone who shapes it. Although people's conception of something is the same, it does not mean that their personal construction does not exist. All of this allows the formation of knowledge in typical construction.

Students are natural conceptions that are humans who always conceptualize at all times, compare natural tendencies and distinguish objects, events, things. To take advantage of this natural tendency, an effective learning environment must be put in place that assigns tasks to students to increase their effectiveness in forming and using concepts, helping them realize in developing skills for completing a task. Guidelines for forming an effective learning environment that is by helping students concentrate on something they understand, and produce ideas; help students develop Understanding chemistry concept of certain knowledge; and converting Understanding chemistry concept into skills in developing categories, making algorithmic formulations, generating and testing hypotheses [8]. [9] argues that the purpose of education is to guide students to be able to integrate their knowledge, expertise, and existing context and use it in solving problems.

In science, including chemistry, study of problems related to natural phenomena and various problems in people's lives. Natural phenomena in science can be viewed from objects, problems, themes, and places of occurrence. Science learning requires investigative activities, both through observation and experimentation, as part of scientific work involving process skills based on scientific attitudes [10]. According to Neuman in [11], scientific attitude (scientific attitude) that must be developed in science learning is honesty, objectivity, endurance, openness, not immediately skepticism, coriousity, being able to hold back from too fasting judgment. Science learning should develop curiosity through discovery based on direct experience in scientific work. With scientific work, students are trained to utilize facts, concepts, principles, theories as a basis for creative, critical, and analytical thinking [10]. According to [12], science process skills in learning and learning science include the skills of observing, measuring, classifying, predicting, concluding, communicating, interpreting data, making operational definitions, making questions, composing hypotheses, conducting experiments and formulating a model.

Science teaching materials, including chemistry, contain two important aspects, namely processes and concepts and must be realized as an indicator of the success of learning. Chemical learning boils down to the knowledge of "how" and "what". "How" refers to understanding mechanisms or procedures for building knowledge about the universe. Whereas "what" refers to the knowledge of the concept of the universe. Chemistry teaching material is abstract, tiered, related to one another, and increasingly complex. Processes and concepts are mandatory phases that must exist in chemical learning. Learning chemistry should lead to mastery of science which is the result of developing knowledge gained by students. Students should be trained in process skills. Students are directed to be able to act as scientists who are able to collect data, sort and categorize data, carry out measurements, analyze relationships, and make conclusions. At a higher level, students can also be directed to compile a hypothesis, design problem solving, and carry out experiments / research [11]. So the learning outcomes of chemistry should include understanding the concepts and skills of science processes.

Process skills in science include basic skills and integrated skills. Basic skills include the skills of observing, classifying, communicating, measuring metrics, predicting / predicting, referring / inferring, and interpreting. Integrated skills include identifying variables, determining operational variables, explaining relationships between variables, arranging hypotheses, designing procedures and conducting investigations / experiments for data collection, processing / analyzing data, presenting the results of investigations / experiments in the form of tables / graphs, and discuss, conclude, and communicate in writing or verbally [10]. In accordance with the nature of science, chemistry learning must therefore rely on scientific processes. The scientific process involves various science process skills. When viewed from the gap, the process of observing / sensing is in the initial position in the science process. Then it is followed by a higher process such as measuring, classifying, and higher skills, namely experimental skills [13]. Based on its level, there are three dimensions of skills, namely basic skills, processing / processing skills, and investigative skills [14].

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 [15]. An understanding of the NOS is an expected characteristic in someone who has scientific literacy, where the person is able to develop an understanding chemistry concepts, principles, theories and processes of science, and is aware of the complex relationships between science, technology and society [16], So, in principle, the NOS includes the conception of science knowledge, values and beliefs in obtaining the science of knowledge, the process of science, and its influence on society, culture, and science technology. However, whether the understanding of NOS plays a role in understanding students' concepts and science process skills is something that still needs to be learned.

2. Method

The research was carried out at the Faculty of Mathematics Education and Science and Science IKIP Mataram. This descriptive study was conducted using the Ex-post Facto method. The research subjects were 75 students participating in the General Chemistry course for the 2018-2019 academic year taken by the saturated sampling method. The research data consisted of Understanding of NOS data, understanding concepts, and science process skills. Understanding of NOS data was obtained using an Understanding of NOS questionnaire filled in by respondents or research subjects. Data on understanding the concepts and skills of science processes are obtained from understanding chemistry concept tests and science process skills observation sheets as they were developed by [17]. The research was carried out in stages, namely: (1) conducting an NOS understanding questionnaire trial; (2) do subject categorization based on understanding the NOS; (3) applying general chemistry learning; (4) observing science process skills and understanding student concepts. The understanding questionnaire of NOS has consisted of 39 items which are predictors of 10 aspects of NOS Understanding. The distribution of the number of items in each aspect of understanding of NOS is presented in table 3 with validity presented in Table 1.

Table 1. Distribution of Questionnaire Item Understanding of NOS

NOS Aspects	Number of Item
Scientific knowledge is tentative	3
Scientific knowledge comes from empirical data	3
Scientific knowledge as a human inference product	3
Human creativity is needed to develop knowledge	5
Scientific method	6
knowledge is inseparable from theory / scientists understanding (theory driven)	3
Scientific Law	4
Scientific theory	5
The social dimension of science	3
Science planting in social and cultural fields	4
TOTAL	**39**

Understanding the NOS questionnaire tested through testing the validity and reliability of the instrument. The NOS understanding questionnaire test was conducted on 84 Mataram IKIP students. Validity was tested using the product moment correlation equation while the reliability of the questionnaire was tested using alpha correlation test with 3 split techniques as suggested in Azwar (2010). Test reliability is categorized by referring to Table 2.

Table 2. Criteria for Instrument Reliability

Koefisien korelasi	Reliability	Correlation
0,80 – 1	Very high	Very strong
0,60 – 0,79	High	Strong
0,40 – 0,59	Fair	Fair
0,20 – 0,39	Low	Weak
0 – 0,19	Very low	Very weak

Data from research results consisting of data on understanding of NOS, understanding concepts, and science process skills were obtained from 75 research subjects. Data is converted so that it has a maximum value of 100. Furthermore the data center symptoms are described [18]. The research subjects were grouped based on their understanding of NOS with the level categorization method as presented in Table 3 [19].

Table 3. Level Categorization

Data Interval	Categoy
$x \geq \mu + 1{,}0\sigma$	High
$\mu - 1{,}0\sigma \leq x < \mu + 1{,}0\sigma$	Medium
$x < \mu - 1{,}0\sigma$	Low

Data is described to be further analyzed by product moment correlation test and One Way Anova test for uncorrelated samples. The group design for the One Way Anova test is presented in Figure 1.

Variation Source		
Understanding of NOS	Understanding chemistry concept (CU)	Science Process Skil (SPS)
High (H)	HCU	HSPS
Medium (M)	MCU	MSPS
Low (L)	LCU	LSPS

Figure 1. Scheme of data group for One Way Anova test

Product moment correlation test [18] was conducted to test the following hypothesis:

H1 : There is a significant correlation between students' understanding of NOS and Understanding of chemical concepts

H2 : There is a significant correlation between students' understanding of NOS and chemical science process skills While the One Way Anova test was conducted to test the following hypothesis:

H3 : There is an influence of students' understanding of NOS towards the Understanding of Chemical Concepts

H4 : There is an influence of students' understanding of NOS on the Chemical Science Process Skills

Data variant conditions the three groups tested must be homogeneous as indicated by the F test results between the groups with the highest variance compared to the group with the lowest variance.

3. Result and Discussion

3.1. Understanding of NOS Questionnaire

The understanding questionnaire of NOS has consisted of 39 items which are predictors of 10 aspects of Understanding of NOS. the validity of each item was tested through product moment correlation technique. The validity of each questionnaire item is presented in table 4. The test results show that the items have met the validity requirements indicated by the value of r for each item higher than the critical product moment for the number of data 84 and the confidence level of 95% which is 0.215. This means that the understanding questionnaire instruments of the NOS that have been compiled can provide valid measurement results and can show the level of understanding of NOS actually responds. However, it is not enough until the validity test, the test questionnaire must proceed towards reliability test to prove whether this can provide steady measurement results or not.

Table 4. Validity Questionnaire Items Understanding of NOS

No Item	r	r table (N = 84; p = 5 %)	Validity	No Item	r	r table (N = 84; p = 5 %)	validitas	No Item	r	r table (N = 84; p = 5 %)	validity
1	0,325	0,215	VALID	14	0,257	0,215	VALID	27	0,222	0,215	VALID
2	0,276		VALID	15	0,414		VALID	28	0,232		VALID
3	0,353		VALID	16	0,354		VALID	29	0,393		VALID
4	0,283		VALID	17	0,239		VALID	30	0,256		VALID
5	0,344		VALID	18	0,268		VALID	31	0,383		VALID
6	0,236		VALID	19	0,270		VALID	32	0,322		VALID
7	0,275		VALID	20	0,332		VALID	33	0,325		VALID
8	0,363		VALID	21	0,410		VALID	34	0,227		VALID
9	0,388		VALID	22	0,343		VALID	35	0,263		VALID
10	0,344		VALID	23	0,261		VALID	36	0,257		VALID
11	0,325		VALID	24	0,311		VALID	37	0,386		VALID
12	0,251		VALID	25	0,288		VALID	38	0,555		VALID
13	0,370		VALID	26	0,234		VALID	39	0,260		VALID

The results of the questionnaire reliability test with the triple split technique on the alpha correlation test showed that the questionnaire of understanding of the NOS that has been compiled has very high reliability as presented in Table 5.

Table 5. Reliability of Questionnaire Understanding about NOS

Variable	N	Analaysis	R Value	Reliability
Understanding of NOS	84	Alpha Correlation	0,802	Very High

3.2. Description of Students Understanding of NOS, Understanding chemistry concept, and Science Process Skills

Data description of Understanding of NOS, Understanding chemistry concept, and Student Science Process Skills are presented in Table 6.

Table 6. Description of Understanding of NOS data, Understanding chemistry concept, and Student Science Process Skills

	Understanding of NOS	Understanding chemistry concept	Science process Skill
N	75	75	75
The highest score	73.85	90.00	87.00
Lowest value	58.97	60.00	50.00
Average	66.58	71.09	64.57
Variant	13.44	70.08	73.36
St. Deviation	3.67	8.37	8.56

3.3. Subject grouping based on understanding of NOS

The distribution of subjects based on their understanding of NOS in the high, medium and low categories is presented in Table 7.

Table 7. Categories of Subjects Based on Understanding of NOS

Category	Understanding of NOS		
	Interval	**Number of Subject**	**Percent**
High	70,26-100	17	22,67 %
Medium	62,92-70,25	47	62,67 %
Low	20-62,91	11	14,67 %
TOTAL		**75**	

Average understanding score of student NOS 66.58 with the highest score of 72.85. most students have a level of understanding of NOS with moderate categories. According to [20], efforts to improve understanding of NOS are still needed in universities. He suggested efforts to improve understanding of NOS were carried out through the application of mobile learning at universities. The description of the understanding chemistry concepts and science process skills in each group is presented in Table 8.

Table 8. Description of Understanding Concepts and Science Process Skills in Each Understanding of NOS Group

		Understanding of NOS		
		Low	**Medium**	**High**
Understanding chemistry concept	Average	67.09	70.29	75.88
	The highest score	75	90	88.5
	Lowest value	60	60	62.5
	Variant	28.191	69.584	69.173
	St. Deviation	5.310	8.342	8.317
Science Process Skill	Average	61.55	62.98	70.24
	The highest score	67	80	87
	Lowest value	53	50	61
	Variant	26.073	67.543	56.316
	St. Deviation	5.106	8.219	7.504

The average Understanding chemistry concept score for students with high, medium, and low levels of understanding of NOS is 75.88, 70.29, and 67.09. The average score of science process skills for students with a high, medium, and low level of understanding of NOS is 70.24, 62.98, and 61.55. The highest understanding chemistry concept score is among students with an understanding of moderate NOS. The lowest understanding chemistry concept score is among students with a low and moderate understanding of NOS. The highest science process skills are among students with a high understanding of NOS. The lowest science process skills are among students with an understanding of moderate NOS. It appears here that, not always students with the highest understanding of NOS will have the highest understanding chemistry concepts and science process skills or vice versa.

3.4. Correlation among Understanding of NOS, Understanding Chemistry Concepts and Science Process Skills

The summary test of the understanding of the NOS correlation with the Understanding chemistry concepts and Science Process Skills is presented in Table 9.

Table 9. Correlation Tests Summary among Understanding of NOS, Understanding Chemistry Concept and Science Process Skills

Variable 1	Variable 2	r	r table (N = 75; p = 5 %)	Conclusion	rxy	Conclusion
Understanding of NOS	Understanding Chemistry Concept	0.380	0,227	Ha accepted	0.994	Very Strong Correlation
	Science Process Skill	0.414		Ha accepted	0.993	Very Strong Correlation

Based on the results of the study it can be concluded that there is a significant and very strong correlation between Understanding of NOS and Understanding chemistry concepts and between NOS. Understanding and Science Process Skills in Students participating in General Chemistry courses at the Faculty of Education MIPA IKIP Mataram.

3.5. Effect of Understanding of NOS on Students Understanding Chemistry Concepts and Science Process Skills

The summary of homogeneity test and ANOVA test of the influence of Understanding of NOS on the Understanding chemistry concepts and Science Process Skills are respectively presented in Table 10 and Table 11.

Table 10. Summary of Homogeneity Tests for Understanding Chemistry Concepts and Science Process Skills based on Understanding of NOS Groups

Variable	F count	F table		Conclusion
Understanding chemistry concept	2,468	dk numerator :	46	Homogeny
		dk denominator :	10	
Science Process Skill	2,591	Significant :	0.05	Homogeny
		F table :	2.65	

Table 11. Summary of Anova Tests Effect of Understanding of NOS on Understanding chemistry concept and science process skill

Dependant Variable

Understanding Chemistry Concept

Variation Source	df	Sum of square	Mean square	F count	F table 5%	Conclusion
Between	2	596.641	298.320	4.680	3,13	Ha accepted
Inside	72	4589.546	63.744			
Total	74	5186.187				

Science Process Skill

Variation Source	df	Sum of square	Mean square	F count	F table 5%	Conclusion
Between	2	763.422	381.711	6.438	3,13	Ha accepted
Inside	72	4268.765	59.288			
Total	74	5032.187				

The results of the One Way Anova test on data understanding chemistry concepts and process science skills with understanding of NOS as a source of variation indicate that alternative hypotheses can be accepted. This means that there are significant differences in data variants on the understanding chemistry concepts and science process skills between groups with an understanding of high, medium, and low NOS. This shows that the level of understanding of NOS that is different is related to differences in scores of understanding chemistry concepts and science process skills achieved by students.

4. Conclusion

Based on the results of the study it can be stated that there is a significant and very strong correlation between Understanding of NOS and Understanding chemistry concepts and between Understanding of NOS and Science Process Skills. There are differences in the understanding chemistry concepts and science process skills that are at a different level of understanding of NOS. This case happened to students participating in the General Chemistry course at the Faculty of Education MIPA IKIP Mataram Academic Year 2018/2019. Therefore, it can be concluded that there is a contribution of the Understanding of NOS of Understanding chemistry concept and science process skill to Students participating in General Chemistry courses at the Faculty of Education, MIPA IKIP Mataram Academic Year 2018/2019. However, Understanding chemistry concept and science process skill is not a direct impact of Understanding of NOS.

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