The Influence of Mobile-NOS Model of Learning towards Students Understanding on the Nature of Science

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Abstract. The Aim of this research was to evaluate the influence of Mobile-NOS model of learning application towards Students' Understanding of the Nature of Science. In the form of pre-experimental research, this study has been carried out by pretest-posttest non-control group design. The research subjects consisted of 27 students participating in the Basic Chemistry II course in the chemical education program of IKIP Mataram academic year 2018-2019 collected by saturated sampling. The Nature of Science Data was obtained using the Understanding of Nature of Science questionnaire. Data were analyzed by paired sample t test. The results showed significant enhancement on students' understanding of the nature of science after Mobile-NOS model of learning application. The value of t count (5.353) is greater than the t table (1.706) in the one-way hypothesis.

1. Introduction

Science learning like Chemistry, at this time, must be able to directing students into problem solvers with scientific characters. Students are natural conceptualizer, able to compare natural tendencies and distinguish objects, and events. To take advantage of this natural tendency, effective learning environments must be able to give students assignments to increase their effectiveness in forming and using concepts, helping them become aware of the development of skills to complete assignments [1]. An effective learning environment is formed by helping students concentrate on something that is understood, produce ideas; help students develop conceptual understanding of certain knowledge; and changing conceptual understanding into skills in developing categories, making algorithmic formulations, generating and testing hypotheses [2]. Learning strategies should encourage the improvement of science process skills which include observing, measuring, classifying, estimating, summarizing, communicating, interpreting data, making definitions, making questions, constructing hypotheses, experimenting and modeling models. Many studies show a correlation between science process skills and learning achievement [3][4][5][6][7].

The achievement of student performance in learning science in the classroom can be achieved through a focus on the ability of the epistemology of science / Nature of Science, understanding of the characteristics of science as a form of human knowledge and inquiry. Subjects materials in science learning that are delivered correctly can contribute to achieving learning goals [8]. The main objective of integrating Nature of Science (NOS) into the science curriculum is to help educate students in solving complex scientific and technological problems in modern life and democratic culture. Establishing

Nature of Science (NOS) as the main component is an important learning goal in every science curriculum [9]. Therefore, the development of learning technology must be oriented to the Nature of Science. Understanding NOS is a characteristic that is expected to exist in someone who has scientific literacy, where that 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[10][11].

Meanwhile, the issue of the industrial revolution 4.0 requires the optimization of the integration of information technology in learning such as mobile technology. There are several reasons why people use mobile technology. Someone believes that using information system technology can help him get more benefits and performance at work, be able to access information quickly, anywhere and anytime, and choose whatever tools he wants. This has a strong influence on young students to use mobile devices for academic purposes [12]. The results of [13] research show that students really like interactivity, accessibility, and convenience of mobile learning. Mobile learning systems can be implemented easily and cheaply as a complement in the learning process. However, the main objective of the mobile learning environment must be for education not for entertainment [14]. The recommendation of studied the integration of technology and pedagogy in the implementation of ICT projects in developing countries are the need for a transition from dictating information to learning that involves students in learning and solving problems. Mobile learning technology can empower students to learn independently and actively plan their own learning[15].

Therefore, [16] initiated the Mobile NOS study. He considered that it was possible to carry out NOS learning by referring to the NOS learning model which provided an inquiry approach suggested [17]. Learning based on the inquiry approach has indeed been proven effective in providing constructivist learning experiences to students and even helps the development of students' scientific literacy[18][19]. However, in the learning experience it has given us a lot of information that inquiry learning requires a long learning time, which is difficult to adjust to the learning time in the chemistry curriculum in Indonesia which is only 200 - 300 minutes per week. Therefore the collaboration of mobile learning in inquiry-based learning such as the Nature of Science (NOS) approach needs to be designed so as to create a mobile-NOS learning model that can be applied effectively and efficiently in a chemistry learning process in schools. In fact the learning experience of inquiry is not necessarily accompanied by the acquisition of a good understanding of all aspects of NOS by. Moreover, in high school (SMA) students, the high school chemistry textbooks in circulation only contain less than 30% of the NOS aspects explicitly [20][21].

Mobile -NOS model of learning is that applies NOS learning steps with the support of learning media in the form of mobile applications that can be applied on smart mobiles. These mobile applications can be in the form of interactive module applications, teaching materials, social media, and learning websites that can be used by teachers and students both inside and outside the classroom. The mobile-NOS learning model must also be able to show the characteristics of the nature of science explicitly through the ongoing learning process. The characteristics of the nature of science are [21]: (1) scientific knowledge that is tentative; (2) Knowledge comes from empirical data; (3) Scientific knowledge is a product of human inference; (4) Human creativity is needed to develop knowledge; (5) Scientific method; (6) knowledge is inseparable from the theory / understanding of scientists (Theory driven); (7) Scientific Law; (8) Scientific theory; (9) The social dimension of science; (10) Cultivation of science in the social and cultural fields. The stages of learning are [16]: Reading the context in electronic articles; Asked questions; Case observation and Inference; Demonstration Procedure; Library Search; Carry out Procedures; Communicating Science Knowledge; Authentic Assessment. Since there is no study yet on the effectiveness of applying the Mobile-NOS learning model to the understanding of the Nature of Science itself, this study is very necessary to be carried out.

2. Method

The research was conducted in the chemical education study program IKIP Mataram in the even academic year 2018-2019. Subjects consisted of 27 students participating in basic chemistry course II

taken by the saturated sampling method. The research design applied in this study was a pre-experimental study conducted with a pretest-posttest non-control group design with the schema as presented in Figure 1 [22].

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2

Figure 1. Scheme of pretest-posttest non control group design
O_1 : Observation of Students Understanding of the Nature of Science before treatment
X : Mobile-NOS model of learning
O^2 : Observation of Students Understanding of the Nature of Science after treatment

The variables studied in this study are the Mobile-NOS learning model as the independent variable and the understanding of the Nature of Science as the dependent variable. The treatment instruments used in this study consisted of Syllabus, RPS, Modules, and Mobile Learning Applications. Understanding data about the Nature of Science was collected using a questionnaire. The measurement instrument used was the questionnaire instrument Understanding the Nature of Science. This questionnaire was tested on 84 subjects. The instrument consisted of 39 valid items with a value of r> 0.215 and very high reliability with a coefficient of r = 0.802. The items in the instrument reveal 10 aspects of understanding the nature of science as suggested namely scientific knowledge is tentative; scientific knowledge comes from empirical data; scientific knowledge is a product of human inference; human creativity is needed to develop knowledge; scientific method; knowledge is inseparable from the theory / understanding of scientists (Theory driven); scientific law; scientific theory; social dimension of science; and planting science in the social and cultural fields [26]. Data were analyzed by descriptive category method with categorization as presented in table 1.

Table 1. Understanding of the Nature of Science Category

Skor	**Criteria**
81-100	Very Good
61-80	God
41-60	Fair
21-40	Less Bad
<21	Very Bad

adopted from [23]

The hypothesis tested in this study is H0: there is no increase in understanding of the nature of science after the application of Mobile-NOS learning; and Ha: there is an increase in understanding of the nature of science after the application of Mobile-NOS learning. The hypothesis was tested using a correlated sample t test [22].

Result and Discussion

The results of the study show the students' understanding of every aspect of the nature of science before and after learning with the Mobile-NOS learning model as presented in Figure 2.

Based on the research results the average score of various aspects of understanding of the nature of student science before learning activities (pretest) is as follows: scientific knowledge is tentative at 69.63; scientific knowledge comes from empirical data of 70.37; Scientific knowledge is a product of human inference of 67.90; human creativity is needed to develop knowledge of 58.52; scientific method 64.07; Knowledge is inseparable from the theory / understanding of scientists (Theory driven) of 78.27; Scientific law at 51.85; scientific theory of 70.07; social dimension of science by 71.85; planting of science in the social and cultural fields by 69.81. The lowest score of students understanding of the nature of science aspects before learning lies in the aspect of scientific law (51.85) with sufficient category. The highest score lies on aspect knowledge cannot be separated from the theory / understanding of scientists (78.27) with a high category. Two aspects of understanding the nature of

science where students have enough categories namely aspects of human creativity are needed to develop knowledge and aspects of scientific law, while the rest are in the good category.

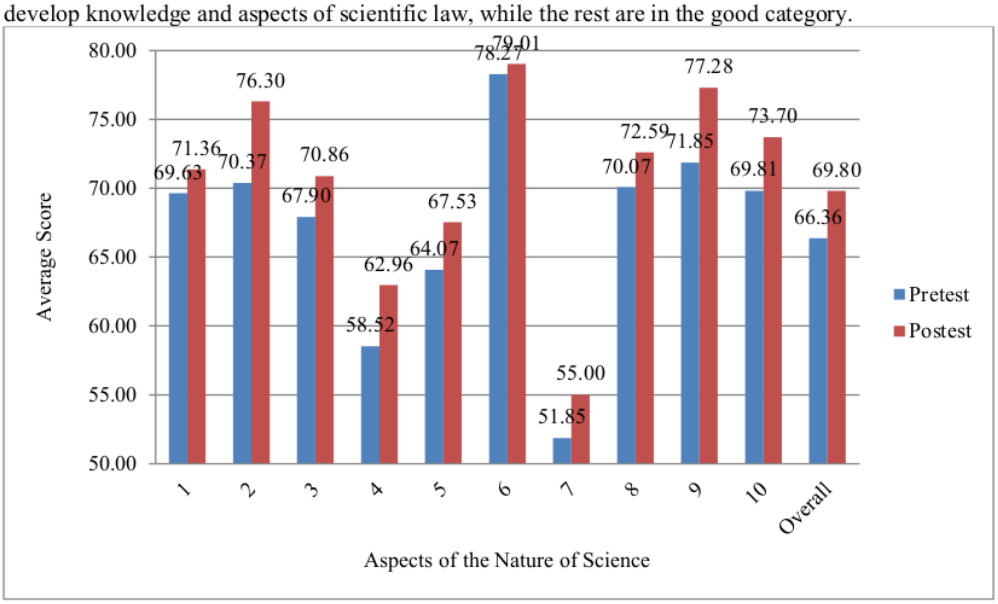

Figure 2. Students Understanding on every aspects of the Nature of Science: (1) scientific knowledge that is tentative; (2) Knowledge comes from empirical data; (3) Scientific knowledge is a product of human inference; (4) Human creativity is needed to develop knowledge; (5) Scientific method; (6) knowledge is inseparable from the theory / understanding of scientists (Theory driven); (7) Scientific Law; (8) Scientific theory; (9) The social dimension of science; (10) Cultivation of science in the social and cultural fields, before and after Mobile-NOS model of learning application

The average score of various aspects of understanding about the nature of student science after the application of learning (posttest) is as follows: scientific knowledge is tentative at 71.36; scientific knowledge comes from empirical data of 76.30; Scientific knowledge is a product of human inference of 60.86; human creativity is needed to develop knowledge of 62.96; scientific method 67.53; Knowledge is inseparable from the theory / understanding of scientists (Theory driven) of 79.01; Scientific law in the amount of 55.00; scientific theory 72.59; social dimension of science at 77.28; planting of science in the social and cultural fields by 73.70. The aspect of understanding the nature of that still in the fair category is the aspect of scientific law, while the rest are in the good category.

The highest increase in the aspect of understanding of the nature of science occurred in the aspect of scientific knowledge derived from empirical data which amounted to 5.93 points, while the lowest increase occurred in the aspect of Knowledge not separated from the theory / understanding of scientists which amounted to 0.74 points. The results are only quite good on the aspects of scientific law in line with the results of research by [20][24] and the increase that occurred was also very low in the aspects of Knowledge not separated from the theory / understanding of scientists. This can be caused by the majority of students believing that scientific knowledge should only be in the form of facts that can be felt by the human senses and should not be abstract. They believe that the phenomenon of sin should be explained as it is without having to involve imaginary human imaginations. Only a few of the students doubted that theory was the fruit of human creativity, while the majority disagreed about it. Most students understand that the scientific method is only in the form of experiments that have hypotheses. Most students do not agree that in building scientific knowledge, even though rational science and objective images must come from data, sometimes the subjective and irrational elements of humans also

work. Most students do not understand the position of law and scientific theory, most of them assume that law is solely derived from logical thinking, and does not agree that theory can develop into law.

Table 2. The t test result of Students Understanding before and after learning

	Pretest	Postest
Average	66,192	69,801
Variance	9,608	18,901
Number of Samples	27	27
Pearson Correlation	0,603	
df	26	
t Stat	5,353	
P(T<=t) one-tail	0,000	
t Critical one-tail	1,706	
P(T<=t) two-tail	0,000	
t Critical two-tail	2,056	

The average understanding of students about the nature of science after treatment (69,801) is higher than before treatment (66,192). The average understanding of students about the nature of science before and after learning is still in high category. T test results show the value of t arithmetic (5.353) which is greater than t table (2.056). That is, students' understanding of the nature of science after applying the Mobile-NOS model is significantly higher than before

Conclusion

Based on the results of the study it can be concluded that there was a significant increase in students' understanding of the nature of science after learning Mobile-NOS. This is indicated by the calculated t value (5.353) is greater than the t table (1.706) in the one-way hypothesis test using paired sample t test to the data of students' understanding of the nature of science

5. Recommendation

Studies about the influence of Mobile-NOS model of learning towards another learning task variables are still needed.

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