c1c3.2019-Mobile-Technology-On-Learning-Through-Mobile-nos-Model-To-Enhance-Students-Awareness-Of-Epistemology-Of-Science

by Yusran Khery

Mobile Technology On Learning Through Mobile-NOS Model To Enhance Students Awareness Of Epistemology Of Science

Yusran Khery, Baiq Asma Nufida, Suryati, Sri Rahayu, Endang Budiasih

Abstract: Student scientific literacy development on learning should be supported by student awareness of epistemology of science achievement. An offline and online environment on mobile learning design can be utilized on this purpose such as mobile-NOS model of learning. The Aim of this research was to evaluate the influence of Mobile-NOS model of learning application towards Students' awareness of the epistemology 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. Data of awareness of epistemology of science was obtained using questionnaire. Data were analyzed by paired sample t test. The results showed significant enhancement on students' awareness of the epistemology 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-tail hypothesis.

Index Terms: Mobile Technology, mobile learning, Mobile-NOS model, awareness of epistemology of science, scientific literacy.

1. INTRODUCTION

The issue of the industrial revolution 4.0 requires the optimization of information technology integration in learning such as mobile technology. There are several reasons why people use mobile technology. Someone believes that by using information system technology can help them get more benefits and performance at work, can access information quickly, anywhere and anytime, and choose whatever device they wants. This has a strong influence on students to use mobile devices for academic purposes [1]. The results of the study of [2] showed that students really liked the 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 [3]. [4] have studied the integration of technology and pedagogy in the implementation of ICT projects in developing countries. The recommendations obtained from the research 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.Chemistry learning at this time must be able to shape students into problem solvers with scientific characters. Students are natural concept maker, able to compare natural tendencies and distinguish objects and events. To take advantage of this natural tendency, an effective learning environment must be able to give students assignments to improve student effectiveness in shaping and using concepts. Students must be able to consciously develop skills to complete assignments. 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 transforming conceptual understanding into skills in developing categories, making algorithmic formulations, generating and testing hypotheses [5]. Learning should encourage the improvement of science process skills that include observing, measuring, classifying, estimating, summarizing, communicating, interpreting data, creating definitions, making questions, constructing hypotheses, experimenting and formulating models. Many studies show a correlation between science process skills and learning achievement [6] [7] [8]. The observations result by researchers that the level of awareness in the epistemology of science in first-year students at IKIP Mataram is 66,192 in the medium category. In line with research [9], most students currently have a moderate level of understanding of NOS. Most of these research subjects are in the intermediate level in their studies at the university. An awareness of epistemology of science can change as it advances to higher levels of study [10]. Undergraduate students should have a high understanding of epistemology of science [11]. Therefore, researchers suggest that efforts to raise awareness in the epistemology of science are still needed at universities.

According to [12], the achievement of student performance in learning science in the classroom can be achieved through a focus on the awareness of the epistemology of science or 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 learning goals [13]. 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 [14]. Therefore, the development of mobile learning technology must be oriented to the nature of science (NOS). Understanding epistemology of science is a characteristic that is expected to exist in someone who has scientific literacy, those 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 [15]. It is possible to carry out NOS learning by referring to the NOS learning model that provides an inquiry approach. Learning based on the inquiry approach has indeed been proven effective in providing constructivist learning experiences to students and even helped develop

- *Yusran khery (corresponding author), Baiq Asma Nufida, and Suryati are currently lecturer of chemistry education program of Mandalika University of Education, Pemuda Street 59 A Mataram, Indonesia, E-mail: yusrankhery@gmail.com*
- *Sri Rahayu and Endang Budiasih are currently professor of chemistry education of Departmenet of Chemistry, Universitas Negeri Malang.*

student scientific literacy [16] [17]. However, in the learning experience it has given us a lot of information that incur learning requires quite 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 reality, the learning experience of inquiry is not necessarily accompanied by the acquisition of a good understanding of all aspects of NOS by students in tertiary institutions. Moreover, in high school students where high school chemistry textbooks in circulation only contain less than 30% of the NOS aspects explicitly [9]. Mobile-NOS model learning 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 epistemology of science explicitly through the ongoing learning process. The characteristics of the epistemology of science are scientific knowledge that is tentative; 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 of scientists' understanding (theory driven); Scientific Law; Scientific theory; The social dimension of science; Planting science in the social and cultural fields. The stages of learning are: reading context in electronic articles, in-depth question and answer, case observation, demonstration of procedures, library research, carrying out procedures, communicating science knowledge, and authentic assessment [12]. However, there are no studies on the effectiveness of applying the Mobile-NOS learning model to enhance the awareness of epistemology of science, so this study needs to be carried out. This study aims to evaluate the impact of the application of mobile-NOS learning on students' awareness of the epistemology of science.

2. METHOD

The research was carried out in the chemical education study program IKIP Mataram in the even semester of the academic year 2018/2019. Subjects consisted of 27 students participating in basic chemistry courses II taken by the saturated sampling method. The research design applied in this study was a pre-experimental research carried out with a non-control group pretest-posttest design [18] with the scheme as presented in Tabel 1.

TABLE 1

Schema of the pretest-posttest non control group design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2

O_1: Awareness of the Epistemology of Science before Learning

X: The mobile-NOS Learning Model

O_2: Awareness of the epistemology of Science after Learning

The variables studied in this study are the Mobile-NOS learning model as the independent variable and awareness of the epistemology of science as the dependent variable. Data on awareness in scientific epistemology was collected using a questionnaire. The measurement instrument used was a questionnaire awareness of the epistemology 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 awareness of the epistemology of science suggested by [9] 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. Data were analyzed by descriptive category method with categorization as presented in Table 1.

Table 1.

Categories of Awareness in the Epistemology of Science

Score	Criteria
81-100	very good
61-80	good
41-60	medium
21-40	bad
<21	Very bad

Adopted from [19]

The hypothesis of this study stated H0: there was no increase in awareness in the epistemology of science after the application of Mobile-NOS learning; and Ha: there is an increase in awareness in the epistemology of science after the application of Mobile-NOS learning. The hypothesis was tested by correlated sample t test [18].

3. RESULTS AND DISCUSSION

The results showed the students' awareness on every aspect of the epistemology of science before and after learning with the Mobile-NOS learning model as presented in Figure 1.

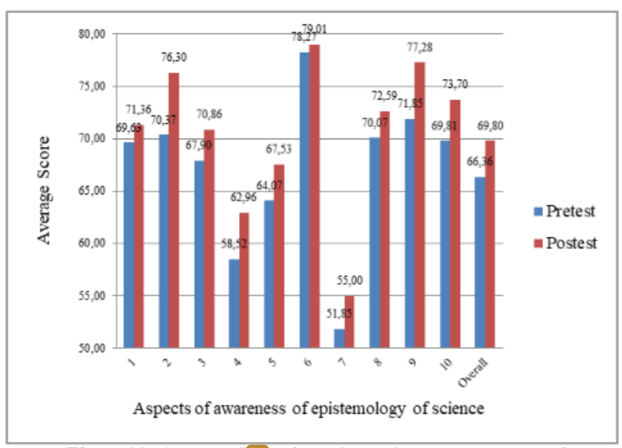

Fig 1. *Understanding of students in every aspect of epistimology of Science before and after the application of the Mobile-NOS learning model. The nature aspects of science: 1. scientific knowledge is tentative; 2. scientific knowledge comes from empirical data; 3. Scientific knowledge is a product of*

human inference; 4. human creativity is needed to develop knowledge; 5. scientific method; 6. Theory driven; 7. Scientific law; 8. scientific theory; 9. social dimension of science; 10. planting science in the social and cultural fields.

Based on the results of the study the average score of awareness students in various aspects of epistemology of science before learning activities (pretest) 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 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 the aspect of epistemology of science before learning lies in scientific law (51.85) with sufficient category. wThe highest score of knowledge cannot be separated from the theory / understanding of scientists (78.27) with a high category. Two aspects of awareness of the epistemology of science with enough categories namely aspects of human creativity are needed to develop knowledge and scientific law. The rest are in the good category. The average scores of various aspects of awareness in the epistemology of science after the application of learning (posttest) are 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 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 epistemology of science aspect still in sufficient category is scientific law. The rest are in the good category. The highest increase in awareness of the epistemology of science occurred in the aspect of scientific knowledge derived from empirical data that is equal to 5.93 points, while the lowest increase occurred in the knowledge aspect not free from the understanding of scientists which amounted to 0.74 points. The results are only quite good in the scientific law aspects in line with the results of the study [9] [20] [21] and the increase that occurred was also very low in the aspects of knowledge that could not be separated from understanding of scientists.

Table 2

t test results in Awareness of epistemology of Science Before and After Learning

	Pretest	Postest
Mean	66,192	69,801
Variance	9,608	18,901
Observations	27,000	27,000
Pearson Correlation	0,603	
Hypothesized Mean Difference	0,000	
df	26,000	
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 results showed that most students believed that scientific knowledge should only be in the form of facts that can be felt by the human senses and should not be abstract. This is in line with what was stated by [22], science must only be in the form of observation and experiment. Students believe that science phenomena should be explained as they are without having to involve imaginary human imaginations. Few students doubt that theory is the result of human thinking creativity, while most disagree about it. Most students believe that the scientific method is only in the form of experiments that have hypotheses. Most students disagree 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 theory of science, most students assume that law is solely derived from logical thinking, and does not agree that theory can develop into law. The average score of students awareness about the epistemology of science after learning (69,801) is higher than before treatment (66,192). The average student awareness about the epistemology 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, student awareness of the epistemology of science after applying the Mobile-NOS model is significantly higher than before. This understanding of the epistemology of science needs to be improved so that students have a greater chance of success in learning science. According to [21], students who have a stronger belief that science knowledge is changing and are more likely to have higher awareness and curiosity in science. Student beliefs about the development of scientific knowledge have a direct effect on the knowledge domain, whereas beliefs about justification of scientific knowledge have direct and indirect effects on the attainment and acquisition of knowledge. Awareness of the science epistemology will support student achievement in learning science [10]. Stages of learning activities in the core part of mobile-NOS learning are reading context in electronic articles, in-depth questioning, case observation and observation, demonstration of procedures, searching literature, implementing procedures, and communicating science knowledge [12]. At the stage of reading context in electronic articles, students are asked to read articles in a mobile application or website that has been provided or recommended by the teacher in learning outside the classroom or in the classroom. At this stage students can understand the characteristics of epistemology of science namely the development of scientific knowledge can influence and be influenced by social, cultural, or community values. In the deep question and answer stage, the lecturer asks in-depth questions related to articles that have been read by students. Lecturers conduct question and answer with students so students know the background knowledge they need. Activities are carried out outside the classroom through groups that the teacher has created on social media or learning websites. At this stage students can understand scientific knowledge can be derived from the results of the inference of scientists. Inference is a reasonable explanation about scientific phenomena or facts that can be seen in daily life or through experimentation. At the stage of case observation and intervention, students are tasked with solving contextual cases through an investigation process. This activity is carried out in class. The lecturer guides students to propose a problem statement and formulate a hypothesis. This activity is carried out through groups that have been made by lecturers on social media or learning websites. At this stage students can understand the scientific knowledge can be derived from the results of the inference of scientists. At the procedure demonstration stage, the lecturer presents a live demonstration of the investigation method related to the case which will be solved through video / picture that has been available through a mobile learning facility. For this purpose, the lecturer can provide the video/image through the learning website, share files or links through social media groups, or ask students themselves to search for videos or related images on internet. Students can understand that science based on empirical data and scientific methods. In the literature search stage, the lecturer guides students to conduct library studies related to learning topics. At this stage the lecturer can explain explicitly the knowledge cannot be separated from the driven theory of previous scientific understanding of a phenomenon or scientific knowledge. Driven theory can be a reference for students in explaining the phenomena they will observe in experimental activities. On this occasion also students can understand about theory and scientific laws, explain the characteristics of theory and scientific law and their position in science. Students can also understand that scientific knowledge is tentative (temporary) which is indicated by the existence of various theories or explanations of a particular scientific phenomenon. Lecturers can also provide understanding that the results of the experiments they will obtain may be different. By understanding that scientific knowledge is tentative, students will be more confident in explaining the results of their observations. At the stage of carrying out the procedure, the lecturer asks students to prepare an investigative procedure. At this stage the lecturer can convey explicitly the scientific knowledge can develop thanks to the creativity of humans/scientists, scientific creativity is needed to develop knowledge. The method compiled by scientists is one of scientific knowledge. The lecturer then asks students to carry out the investigative procedures that they have compiled. Students are also allowed to make modifications to the procedure during the practicum process if the procedures they have prepared previously have weaknesses or obstacles in implementation. At this time students can understand the role of carrying out experimental procedures in order to obtain empirical data, because science knowledge is built on empirical data. At the stage of communicating science knowledge, lecturers can ask students to prepare reports on the results of their activities based on the agreed format, or ask students to fill in the report formats that have been prepared by lecturers in the form of Student Worksheets. After preparing a report or worksheet, the lecturer can ask students to present the results of their experiments in a group discussion. At this stage students can gain an aware of the social dimensions of science that require a form of appreciation for the work, experiments, or critical ideas to scientists. The form of appreciation can be in the form of providing opportunities for scientists to present their findings. Then more than that, actual scientific knowledge can be disseminated in this way. Knowledge of science can be a reference or basis for the development of scientific knowledge. At this stage students are also welcome to include appropriate solutions that are considered for the problem. The lecturer can explain explicitly about the role of science in the social and cultural fields, where science develops to solve human and environmental problems, improve the quality of life, or balance out lifestyles. The application of science products must consider the socio-cultural aspects of society.

Learning oriented with nature of science (NOS) can encourage students to become: 1) utilitarian, understand science and how to manage technological objects and processes in everyday life, 2) democratic, able to make decisions on socio-scientific issues, 3) cultural, can appreciate the value of science as part of contemporary culture, 4) morals, able to develop an understanding of the norms of scientific community that embody moral commitments about general values to society, 5) science learning: able to facilitate in fulfilling the tasks of learning science subject material. Learning based on Nature of Science can make students' abilities in applying concepts and awareness of the epistemology of science better [23][24]. However, this study shows that the increase that occurred in awareness of the epistemology of science is still relatively low at 69,801. In contrast to studies conducted by [23], awareness of the epistemology of science of junior high school students reached an average of 79.17. This could have happened due to differences in the measurement instruments for awareness of the epistemology of science used. In addition, the implementation of learning that is very short in this study, only one learning activity, causing the increase that occurred is still relatively low. Learning that explicitly includes nature of science, whether integrated with the material or not, can be used to improve students' awareness of the epistemology of science. However, it needs to be considered the use of learning time must be realistic [25][26]. Therefore it is very necessary to consider providing a more learning experience so that the achievement of awareness of the epistemology of science can be higher. Awareness of the science epistemology can have an impact on student performance in the science learning process. Other studies have shown that NOS-oriented learning can positively influence the understanding and belief in the epistemology of science, the ability to apply concepts, and learning outcomes [23] [24] [25] [27]. Whereas this study is limited to only learning about the impact of applying the mobile-NOS learning model to awareness of the epistemology of science. Therefore, studies that evaluate the effect of applying the mobile-NOS learning model to other aspects of science learning performance such as scientific literacy and critical thinking skills are still needed.

4. CONCLUSION

Based on the results of the study it can be concluded that during the process of applying the mobile-NOS learning model students' awareness of the epistemology of science is in the good category. There was a significant increase in students' awareness of the epistemology of science. The value of t arithmetic (5.353) in the awareness of the epistemology of science data before and after learning is greater than t table (1.706) in the one-way hypothesis test using paired sample t test. Student awareness of the epistemology of science after learning is significantly higher than before learning. Student awareness of the epistemology of science increases in every aspect due to the application of mobile-NOS learning with an average increase of 3,609, from an average of 66,192 to 69,801. Therefore, it can be concluded that the application of the mobile-NOS learning model can improve students' awareness of the epistemology of science.

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