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Mobile Learning with Oriented Nature of Science (NOS):

Does undergraduate school need it?

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***Abstract*—This study has been carried out to describe several factors that are considered necessary for the development of mobile learning with NOS (Nature of Science) oriented in chemistry education program of IKIP Mataram. These factors are students understanding of NOS, NOS-oriented on chemistry course, NOS characteristic in teaching materials, utilization of mobile technology in learning, responses about the development of mobile learning with NOS oriented. In the form of descriptive research, data was collected by questionnaires and observation sheet. Research respondent consisted of 54 students and 12 lecturers. The results of the study show that the development of mobile learning with NOS oriented in chemistry education program of IKIP Mataram is very important. The average of students understanding of Nature of Science (NOS) is quite good that is equal to 47,86 %. NOS-oriented on chemistry course were 56,68 % with quite good categories. NOS characteristic on lecture teaching materials were 63,39 % with good category. Utilization of mobile technology in learning is quite good that is equal to 55,56 %. Responses about the development of mobile learning with NOS oriented is 85.23 % with very good categories.**

Keywords—mobile learning; NOS oriented; chemistry education program

I. INTRODUCTION

There are several reasons why people use information technology. Someone believes that using information systems technology can help him get more benefits and performance in work. Mobile technology helps one to access information quickly, wherever and whenever, and choose whatever device they want. One can easily join individually with technology or information systems and innovate. This has a strong effect on young students to use mobile devices for academic purposes [1].

The previous research show that students really like interactivity, accessibility, and comfort of mobile learning. The mobile learning system can be applied easily and cheaply as a complement to the learning process [2]. In applying mobile learning motivational factors need to be considered as interactive and interesting. However, the main purpose of the mobile learning environment must be for education not for entertainment [3].

It has been studied that the integration of technology and pedagogy in the implementation of ICT projects in developing countries [4]. This research designs an educational innovation that utilizes mobile technology in learning. The recommendation obtained from the study which stated that humans naturally ask questions about the real world, doing that is an important way to learn [4]. There needs to be 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.

According to Alden, there are 10 important things that need to be present in mobile learning at the university, that is, users can receive notifications and reminders about assignments and appointments about the class being followed; Users can communicate individually with lecturers, advisers, or other students using voice, email, or text messages; Users can post or reply to items in polls, discussion boards, or other applications; Users can search and access only web-based information; Download and review lesson material from the classes that are followed; Users can interact directly and review administrative information about the class being or will be taken; Users can search or review material at the university library; Users can upload items they record with their personal mobile devices; Interactive during direct learning sessions; and Users can register or withdraw from the class they are attending [5].

The development of mobile learning technology must be in line with the development of the science learning curriculum in the world. The trend in science education policies emphasizes the importance of scientific literacy as outcomes that can be transferred in science education [6]. Building scientific literacy means focusing on building students 'knowledge to use scientific concepts meaningfully, thinking critically and making balanced decisions on issues relevant to students' lives. However, often the practice of science learning still ignores the social dimension of education and encourages the development of active participation skills in society [7].

Science literacy is increasingly needed today so that we can live in the midst of modern society. For all these reasons, scientific literacy is considered as a key competency [8]. The scientific literacy assessment framework covers aspects of

context, competence, knowledge, and attitude [9]. Science literacy includes three competencies namely explaining the phenomena of science, evaluating and designing scientific inquiry, interpretation of data and evidence of science [10-12]. The average ability of Indonesian students to arrive at the ability to recognize basic facts, but has not been able to communicate and link these abilities with science topics. Students experience difficulties in getting meaning and using science to solve various problems that occur in everyday life [13].

The achievement of students' scientific literacy can be pursued through the teaching of science in a class that focuses on the ability of science / scientific essence of science (Nature of Science) or an 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 the objectives of one's scientific literacy training [14]. Chemical learning contributes to chemical literacy in particular, and scientific literacy in general [11]. The main objective of integrating Nature of Science (NOS) into the science curriculum is to help educate students to become citizens who have scientific literacy so that they can solve complex scientific and technological problems in modern life and a democratic culture. The determination of NOS as a major component in scientific literacy is an important learning goal in every science curriculum [15]. Therefore, the development of mobile learning technology should be oriented to Nature of Science.

Nature of Science (NOS) refers to the epistemology of science, science as a way to find out, or the values and beliefs inherent in the development of science / scientific knowledge [16]. Understanding of the NOS is a characteristic that is expected to exist in someone who has scientific literacy, where the person is able to develop understanding of concepts, principles, theories and processes of science, and realize the existence of a complex relationship between science, technology, and society [17]. So, in principle NOS includes a conception of science knowledge, values and beliefs in acquiring science knowledge, as well as its influence on society, culture and science technology. NOS-oriented learning (Nature of Science) has six main steps, namely: (1) background readings, (2) case study discussions, (3) inquiry lessons, (4) inquiry labs, (5) historical studies, (6) multiple assessments [18].

How understanding NOS and the experience of obtaining NOS through a form of mobile learning is an issue that still needs to be studied and developed. This study was carried out to reveal various important reasons and factors that need to be considered for the development of NOS-oriented mobile learning in the IKIP Mataram Chemical Education Study Program.

II. METHOD

This study uses a descriptive design to describe NOS on student understanding, learning orientation, and teaching materials. The use of mobile technology in learning, and the response to the development of NOS-oriented mobile learning in the chemistry education program of IKIP Mataram also described.

Using saturated sampling technique, the sample consisted of 54 students and 12 lecturers of the chemistry education program of IKIP Mataram in the academic year 2017-2018. Data was collected by questionnaire and observation methods. The data obtained were confirmed by interview techniques. The instrument used consisted of four closed questionnaires and an observation sheet.

The questionnaire of understanding of the nature of science (NOS) is a questionnaire used to reveal students' understanding of the nature of science. This questionnaire has been prepared by researchers through trials on 35 samples. The results of the tests are presented in Table 1. The results of the tests show that each item in the questionnaire is valid with a high reliability (> 0.6). This questionnaire consists of 22 positive statement items and 17 negative statement items with a choice of disagree, doubt, and agree answers. A score of 0, 1, and 2 respectively is given for answers to positive statements and vice versa on negative statements.

The questionnaire of the application of NOS-oriented learning is a questionnaire that is used to reveal the percentage of NOS orientation in learning of chemistry subject material mastery lesson. This questionnaire consists of 20 question items that can be answered by students with choices never, rarely, often, and always. A score of 0, 1, 2, and 3 respectively is given for answer choices that intersect.

Questionnaire of the use of mobile technology is used to reveal how many lecturers utilize mobile technology in learning. This questionnaire consists of 6 statements that are responded with no, rare, and often answer choices. The questionnaire of the development of NOS-oriented mobile learning was used to reveal the response of students and lecturers about the development of NOS-oriented mobile learning. This questionnaire consists of 16 statement items that can be responded with the choice of disagreeing, hesitating, and agreeing. In both of these questionnaires, scores of 0, 1 and 2 were respectively given for the response choices.

TABLE I. RESULTS OF QUESTIONNAIRE TRIALS

Questionnaire	N	Number of Item	Average of Validity	Alpha (α) Correlation	rtable	Conclusion
Understanding of NOS	35	39	0.359	0.64	0.334	high reliability
Application of NOS-oriented learning	35	20	0.358	0.72		high reliability
The use of mobile technology on learning	35	6	0.401	0.67		high reliability
The development of NOS-oriented mobile learning	35	16	0.379	0.79		high reliability

While observation through by observation sheets for NOS characteristics in teaching materials. This instrument is used to evaluate how much NOS characteristics appear in teaching materials compiled by lecturers in the subjects of mastering chemistry subject materials. Observation sheets are filled based on whether or not the NOS aspects are delivered either implicit or explicit in the instructional material created by the lecturer. A score of 0 if there is none and a score of 1 if any.

After data is collected through questionnaires and observations, interviews are conducted to confirm respondents' responses and observations data. The interviews were conducted on 9 students and 3 lecturers. The data obtained were analyzed by calculating percentage.

Description of the results of data analysis is done by referring to the percentage of category as presented in table 2.

III. Results and Discussion

A. Students Understanding about Nature of Science (NOS)

Based on the results of the study, the students' understanding of the Nature of Science was 47.86% with good criteria. The percentage of students' understanding on each aspect of NOS characteristics is presented in Table 3.

The results showed that students had a good understanding of science in aspects of scientific knowledge derived from empirical data and aspects of the social dimension of science. Students have understood that scientific knowledge is obtained through experiments to be able to collect data. But there are still many who think that scientific knowledge is sufficient is something logical even though it is not supported by empirical data. In the aspect of the social dimension of science, students have a very good understanding of the appreciation for previous inventors and are good enough to understand the nature of science that is built not apart from scientific agreement.

Students understanding on NOS quite well in the aspect of scientific knowledge as a product of human inference, the role of creativity in the development of knowledge, scientific methods, the role of theory driven, scientific law, and scientific theory. This is due to most of student believe that science knowledge can only be understood in the form of concrete fact instead of the abstract one.

They believe that the scientific phenomenon should be explained as it is without having to involve human imaginations. Only a few of the students doubt that the theory was created by human thinking creativity, while most of them disagree about it. Most students understand that the scientific method is only in the form of experiments that have a hypothesis. Most students do not agree that in building science knowledge, even though scientific rationales and objective images must be based on data, sometimes subjective and irrational elements of humans also work. Most students do not understand the comparative position of scientific law and theory, most of them assume that law is solely derived from logical thinking, and does not agree that theory can develop into law.

Bad students understanding on NOS aspects of scientific knowledge is tentative and science in the social field of culture. Most students do not agree that professional knowledge is temporary and the results of the investigation of the same object may change. Even though this should be able to be understood from learning about atomic models or other chemical theories. Most of them believe that scientific knowledge is standard and definite. Most students agree that scientific development should pay attention to aspects of human needs, and some of them agree that competitiveness can affect culture. However, they did not agree that the socio-cultural aspects could affect science and its development.

TABLE II. Criteria of Percentage

Percentage	Category
81-100	Very Good
61-80	Good
41-60	Quite Good
21-40	Bad
<21	Very Bad

TABLE III. Students Understanding about NOS

NOS Characteristic Aspect	Percentage	Category
Scientific knowledge is tentative	24.07	Bad
Scientific knowledge comes from empirical data	61.11	Good
Scientific knowledge as a product of human inference	44.44	Quite good
Human creativity is needed to develop knowledge	52.22	Quite good
Scientific Method	51.85	Quite good
Knowledge cannot be separated from the theory/ understanding of scientists (Theory driven)	48.15	Quite good
Scientific Law	41.67	Quite good
Scientific Theory	42.22	Quite good
The social dimension of science	75.93	Good
Science in social and cultural fields	38.89	Bad
Total Average	47.86	Quite good

B. Implementation of NOS Oriented Learning in Lectures

The following is described NOS-oriented on chemistry subject material mastery lesson. This means that understanding NOS is delivered in the learning of chemistry subject material mastery lesson both implicitly and explicitly. This description is obtained from the responses of student to the questionnaire items given about how much learning activities have been oriented towards achieving understanding of NOS in addition to achieve understanding of chemistry subject material. Participants' responses about the level of NOS oriented in the learning/lecturing were 56.68% with the category of quite good. Data description can be seen in table 4.

Based on the results of the study, it is known that in the application of learning, NOS is mostly conveyed implicitly rather than explicitly (direct). This shows that lecturers rarely convey directly to almost all aspects of NOS characteristics, except in scientific method. In the characteristic aspect of the scientific method, the percentage of application is implicitly very good because of most subjects carried out with practicum. While the explicit application is in a good category because

some students consider that only a part of the lecturers explain in detail some of the principles of the scientific method.

The orientation of NOS on aspects of scientific knowledge is tentative, scientific knowledge comes from empirical data, scientific theory, and the cultivation of science in the social and cultural fields of good category. Good categories are obtained in implicit application but only quite good in explicit application. This shows that, although most subjects have described various theories about a particular chemical study, according to students there are very few lecturers who give confidence that science knowledge is temporary and may change. Most students believe that all scientific knowledge is standard, permanent, and will never change. In the aspect of scientific knowledge derived from empirical data, students assume that science knowledge is implicitly derived from empirical data that they can obtain when practicing or experimenting. However, the delivery of this understanding is still rare in lectures in class, especially in courses that contain more chemical theories. Likewise, with the aspect of g science in the socio-cultural field. Some students argue that an explanation of the understanding of how social and cultural can affect science they have never found in lectures. They believe that science can influence culture, but doubt about the opposite.

NOS orientation in learning is quite good on aspects of scientific knowledge is a product of human inference, knowledge is inseparable from scientific theory / scientist understanding, scientific law, and the social dimension of science. However, the NOS orientation is explicitly bad. According to the learning, students argue did a lot of discussion about various theories and their inventors, but did not explain that the theory was the result of human inference and the naming of the theory according to the inventor was a way of giving appreciation. They claimed that they were still confused about the scientific law characteristics and scientific theory. They had never received an explanation about the differences between scientific law and theory.

For the aspect of human creativity is needed to develop knowledge applied with bad. Most students admitted that they were never given the opportunity to modify the procedure in the lab practice. They taught scientific procedures and methods of scientific communication (compilation of reports) do not require modification efforts. Most of them believe that it is enough to use existing scientific procedures without having to modify. Most of the students also claimed to have never received an explanation that human creativity is needed to develop knowledge. Some of them assume that creativity only works to produce creative works that are material or works of art not scientific knowledge.

TABLE IV. PERCENTAGE OF NOS ORIENTED APPLICATION ON LEARNING

NOS Characteristic Aspect	Percentage of Implicit Implementation	Percentage of Explicit Implementation	Average	Category
Scientific knowledge is tentative	75.71	49.71	66.05	Good
Scientific knowledge comes from empirical data	71.57	45.57	61.90	Good
Scientific knowledge as a product of human inference	54.79	28.79	45.12	Quite good
Human creativity is needed to develop knowledge	49.43	23.43	39.76	Bad
Scientific Method	82.71	62.71	77.05	Good
Knowledge cannot be separated from the theory / understanding of scientists (Theory driven)	52.29	26.29	42.62	Quite good
Scientific Law	65.95	39.95	56.28	Quite good
Scientific Theory	71.57	46.57	62.24	Good
The social dimension of science	59.57	31.57	48.24	Quite good
Science in social and cultural fields	77.29	51.19	67.59	Good
Total Average			56.68	Quite good

C. *Characteristics of NOS in Teaching Materials*

The percentage of each NOS characteristic in teaching materials is obtained from how many characteristics of NOS that appears in each teaching material made by the lecturer. Teaching materials consist of books, modules, laboratory work instructions, and presentation material. Each lecturer has six to eight teaching materials for each chemistry subject lecture. The percentage of each NOS characteristic in teaching materials is presented in table 5.

The results showed that the characteristics of NOS in Teaching Materials compiled by lecturers in the subject of mastery of chemistry subject material were 63.39% with good categories. Very good NOS characteristics are found in the characteristics of the scientific method. This is caused by the majority of subjects accompanied by an introduction to the experience of carrying out scientific methods through laboratory work practice. While some of the other courses present descriptions of how experiments were carried out by previous researchers. Experiments that cannot be practiced on campus laboratories are presented in the form of illustrations pictures, schemes, or videos.

While the characteristics of scientific knowledge are tentative, scientific knowledge comes from empirical data, scientific law, scientific theory, and the cultivation of science in the socio-cultural field appears with good categories. This is caused by the majority of teaching materials that have displayed various changes in chemical theories, supporting legal data and scientific theories.

However, in the aspect of scientific knowledge as a product of human inference, knowledge cannot be separated from the understanding of scientists, and the social dimension of science appears with quite good category. This is caused by only a small part of the teaching material presents the background

history of the discovery and the scientists' way of thinking. When delivering chemistry teaching materials, some lecturers do not present scientific law names that correspond. For example, in the matter of the colligative nature of the solution, it is conveyed without introducing Roult's law. There are no lecturers who describe scientific law standing compared to theory.

D. *Utilization of Mobile Technology in Learning*

The level of utilization of mobile technology in learning by lecturers is quite good, reaching 55.56%. The percentage of the use of mobile technology by the IKIP Mataram chemical education lecturers in several aspects that are the focus of this study is presented in table 6.

The results showed that most of the lecturers had utilized mobile technology for the purpose of communication and discussion with students. Lecturers have utilized mobile technology for the purpose of finding information and learning resources and conveying learning tasks to students well. Utilizing existing mobile applications to convey the subject matter is quite good. However, only a small number of lecturers have made mobile technology-based applications for learning needs and very few lecturers have made mobile learning as a planned learning strategy and stated in the learning plan implementation document.

E. *The Importance of NOS-Oriented Mobile Learning Development*

Respondents' responses about the importance of developing NOS-oriented mobile learning are presented in Table 7. The results of the study showed an average response of 85.23% in the very good category.

This shows that students and lecturers respond positively to the development of NOS-oriented mobile learning. Questionnaire statement items are important reasons that must be considered in the development of this learning model. Most respondents consider it very important to develop NOS-oriented mobile learning. They assume that through the learning model individual communication between lecturers and students can be carried out more flexibly and comfortably through mobile communication media. They hope there are warnings and reminders about when the deadline for tasks is collected. Respondents want a special learning web that can be accessed by class participants. Respondents also hoped to be able to obtain administrative information about the programmed classes such as exam schedule info administrative requirements for attending lectures, etc.

TABLE V. CHARACTERISTICS OF NOS IN TEACHING MATERIALS

NOS Characteristic Aspect	Percentage (%)	Category
Scientific knowledge is tentative	72.71	Good
Scientific knowledge comes from empirical data	68.57	Good
Scientific knowledge as a product of human inference	51.79	Quite good
Human creativity is needed to develop knowledge	46.43	Quite good
Scientific Method	85.71	Very good

Table 5. Cont.

Knowledge cannot be separated from the theory / understanding of scientists (Theory driven)	49.29	Quite good
Scientific Law	62.95	Good
Scientific Theory	68.57	Good
The social dimension of science	53.57	Quite good
Science in social and cultural fields	74.29	Good
Total Average	63.39	Good

TABLE VI. UTILIZATION OF MOBILE TECHNOLOGY IN LEARNING

Item	Percentage (%)	Category
Utilizing Mobile technology for communication and discussion with students	87.50	Very good
Utilizing mobile technology to search information and learning resources	70.83	Good
Utilizing mobile technology for the delivery of learning tasks	66.67	Good
Make a mobile application for learning needs	37.50	Bad
Deliver material to students through an existing mobile application.	54.17	Quite good
Making mobile learning part of the part listed in the lesson plan	16.67	Very bad
Total Average	55.56	Quite good

TABLE VII. RESPONSE TO NOS ORIENTED LEARNING DEVELOPMENT

Item	Percentage	Category
Providing media for individual communication between lecturers and students	88.87	Very good
Receive alerts and reminders about the time to collect tasks	92.96	Very good
Web is available for class access and web-based information retrieval	86.90	Very good
Obtain administrative information about the programmed class	87.90	Very good
Arrangements for interaction schedules during indirect and direct sessions	86.92	Very good
Send and answer questions and discussion items through mobile media	85.86	Very good
Search and view lesson material from the campus library	88.97	Very good
can download and view lesson material from the programmed class	86.90	Very good
Registration or resignation from class	90.93	Very good
Upload documents that have been collected and recorded	92.89	Very good
Experience implementing scientific methods	83.82	Very good
Characteristically charged material (NOS) characteristics explicitly	79.82	Good
Provides experience in identifying contextual problems	92.91	Very good
Give experiment planning experience	70.18	Good
Provide experience of data analysis and conclusion	79.27	Good
Provides a diverse and authentic evaluation	68.55	Good
Total Average	85.23	Very good

IV. CONCLUSION

The average of students understanding of Nature of Science (NOS) is quite good that is equal to 47.86%. NOS-oriented on chemistry course were 56.68% with quite good categories.

NOS characteristic on lecture teaching materials were 63.39% with good category. Utilization of mobile technology in learning is quite good that is equal to 55.56%. Responses about the development of mobile learning with NOS oriented is 85.23 % with very good categories. This study has shown how important the development of mobile learning with NOS oriented in chemistry education program of IKIP Mataram. Student's understanding of NOS still need to be improve with the support of mobile learning and teaching materials that contain the characteristic of NOS.

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