Identifying pre-service chemistry teachers’ view of the nature of science and technology’ for ionic liquids as cellulose solvent

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Abstract. This research aims to indentify the views of pre-service chemistry teachers about the nature of science and technology. This research was conducted using descriptive methods with participants consisting of 28 students of the Universitas Lampung. Data was collected using a view of the nature of science and technology (VNOST) questionnaire consisting of 4 aspects: Definition of science and technology, Epistemology of science, Sociology of Internal science, and external sociology of science. The results of this study indicate that pre-service teachers define science as a concept and technology as a science application. In the epistemology of science, they view scientific models as genuine objects and there are many ways to calcify. In internal science sociology, scientific decisions are based on previous theories and technological decisions based on their impact on society. For external sociology of science, pre-service teachers who agree with science-technology-society influence and influence each other. In general, the results also revealed that most of them had a good view. The results of this research will be made didactic design in the context of ionic liquids as cellulose solvents to improve the ability of VNOST pre-service chemistry teacher.

1. Introduction

Based on the 2015 PISA results, the scientific abilities of Indonesian students mostly depend on low levels [1]. This shows that in Indonesia students have a low literacy ability. One way to overcome this can be done by increasing literacy skills such as increasing curiosity about science itself. According to Salmon there is a big influence when learning science is discussed about the science of not only what supports science but also how science is taught [2]. In designing science-oriented learning, a teacher must have an understanding of NOS (Nature of Science), because NOS will be used to determine actions and activities that will be developed in the learning process [3]. In addition, the relationship between the teacher's views about the nature of science and the transfer process in learning includes complex problems and challenging [4]. Some ways that can be done by the teacher to develop NOS students are through laboratory activities, learning modules to develop a product, the language of the teacher in teaching [5]. Through the discussion of scientific ideas through the examples given, there will be a process to develop their NOS abilities.

To strengthen scientific literacy, in addition to the NOS aspect, a critical understanding of Nature of Technology (NOT) is also needed and how technology relates to science but also with society [6]. As
research has conducted examine the views on the nature of science and technology in junior high school students in Bandung, generally junior high school students have insufficient views on the nature of science and technology [7] with the low ability of a student’s VNOST it will be difficult to understand the concept overall. The role of the teacher as a facilitator is very important to develop students' abilities by designing appropriate learning. Science will be more meaningful for students when learning in the relationship between science and technology is clarified and how the role of technology in society or the role of society in science [8]. Before that, a teacher must understand their point of view of the nature of science and technology because it will affect VNOST abilities of students. Indeed the teacher will teach a science and how a teacher teaches will be influenced by their views [9].

The test results of the views of the nature of science and technology that have been carried out by Tairab using the NOST questionnaire to teachers and pre-service teachers show that in general, both teachers and pre-service teachers have the same view regarding the nature of science and technology [10]. Some students still think that science is a scientific discipline including biology, chemistry, and physics while for technology both teachers and pre-service teachers tend not to understand technology with science and see technology as an application of science. Through education, it is expected to contribute to developing science and technology [10]. One way that has been done to develop an understanding of the relationship between science-technology-society pre-service teachers with techno science-based learning through practical activities using an inquiry worksheet to make conductive glass [11]. Ionic liquids are also one of the interesting topics that can be applied in chemistry education as one of the rapidly developing fields of modern chemistry, technology, and engineering (technochemistry) [12]. Based on the results of previous research that has been done, this research will examine the views of pre-service chemistry teachers regarding the nature of science and technology using existing questionnaire. The aims of this study is to determine the views of pre-service chemistry teacher students regarding the nature of science and technology. This research is the first step in designing a learning oriented to the nature of science and technology. To strengthen the pre-service chemistry teachers’ VNOST, the context to be studied is ionic liquid as a solvent for cellulose.

2. Methods
Participants were 28 chemistry education students at the Universitas Lampung. They consist of five sixth semester students and 23 eighth semester students. Students are given 30 minutes to fill out the questionnaire. The instrument used in this study was a VNOST questionnaire. This questionnaire will be used as a basis for design learning ionic liquid as a solvent for cellulose. This questionnaire was adapted from the Views on Science-Technology-Society (VOSTS) questionnaire [13] which has been tested for reliability and validity. Based on the VOSTS questionnaire, several questions are selected according to the needs of NOST aspect testing. The questionnaire consists of 8 multiple choice questions. The four aspects of VNOST that will be tested in the questionnaire are definitions of science and technology, epistemology of science, external sociology of science and internal sociology of science. At each answer option, it ends with three choices of the same viewpoint, namely:

X: I don't understand
Y: I don't have enough knowledge to make a choice
Z: There isn't one of the choices above that fit my view.

The data obtained are then categorized into three categories, namely R, HM, and N. The category "R" indicates that the views of students are in accordance with a legitimate view. The category "HM" indicates that the views of students partly express legitimate views and the category "N" indicates the views held are not in accordance with legitimate views [14]. The data obtained were analyzed using the frequency distribution of each category for each question.

3. Result and Discussion
This study examines the views of pre-service chemistry teachers regarding the nature of science and technology. As for the aspects of NOST that were tested consisted of four aspects, namely the definition
of science and technology, Epistemology of Science, Internal Sociology of Sciences and External Sociology of Science. Based on the choice of answers that have been selected by students in the questionnaire, the choice of answers for each student is then calculated and grouped according to existing categories. The views of students regarding the nature of science and technology as a whole are shown in Table 1. The explanation of each aspect of the NOST and the results will be explained as follows.

3.1. Definition of Science and Technology
In the aspects of the definition of science and technology, the sub-aspects to be tested are the definition of science, the definition of technology and the relationship between science and technology. In the science definition sub-aspect, students are given question about the definition of science with choice of answers consisting of 10 statements. Based on the results obtained 85.7% of students are in the HM category, 14.3% are in the R category and there is no N category. In the Has Merit category, most students define science as a body of knowledge such as principles, law, and theory, which explains the world around us. The others classified as Has Merit consider science as a field of science such as biology, chemistry, and physics. This is in accordance with Tairab’s research which reveals the results of his research in the Has Merit category which considers science as a body of knowledge [6]. In the Realist category, there are two definitions of science, namely science in the form of experimental activities to solve problems related to the world around us and the process of investigating unknown things and discovering new things about the world and the universe and how it works. This is consistent with the results of previous studies that both teachers and pre-service chemistry teachers in the Realist category regard science as a systematic investigation process [6] as explained by American philosopher L-Laudan that science is basically an activity to solve problems [15] and as knowledge explain the world [6].

| Questions | Sub aspects NOST | Many choices in categories | Percentage Per Category |
|-----------|------------------|---------------------------|-------------------------|
| 1         | Definition of science | R | 4 | 14,3 |
|           |                  | HM | 24 | 85,7 |
|           |                  | N | 0 | 0,0 |
| 2         | Nature of the Scientific Model | R | 8 | 28,57 |
|           |                  | HM | 14 | 50 |
|           |                  | N | 6 | 21,42 |
| 3         | Nature of the Classification Scheme | R | 16 | 57,13 |
|           |                  | HM | 1 | 3,57 |
|           |                  | N | 11 | 39,28 |
| 4         | Scientific Decision | R | 9 | 32,14 |
|           |                  | HM | 17 | 60,65 |
|           |                  | N | 2 | 7,1 |
| 5         | Definition of technology | R | 7 | 25 |
|           |                  | HM | 21 | 75 |
|           |                  | N | 0 | 0,0 |
| 6         | Relationship between science and technology | R | 6 | 35,71 |
|           |                  | HM | 21 | 46,43 |
|           |                  | N | 1 | 3,57 |
| 7         | Technology Decision | R | 10 | 21,43 |
|           |                  | HM | 13 | 75 |
|           |                  | N | 5 | 3,57 |
| 8         | Science-technology-society relations | R | 21 | 75 |
|           |                  | HM | 6 | 21,43 |
|           |                  | N | 1 | 3,57 |

Note: R = Realist; HM = Has Merit; N = Naïve

In the definition of technology, students are asked about the definition of technology as many as 25% of students are in the Realist category, with the definition of technology is the process of creating, designing, developing and testing devices, tools, and instruments. As many as 75% of students are in the category of Has Merit, with the definition of technology as the application of science that is useful to improve the quality of life and various objects made by humans such as devices, tools and instruments. No student is in the Naïve category to define technology. In this sub aspect, the results of the study are
different from those of Tairab. In Tairab study, both teachers and pre-service teachers define technology as being largely in the Naive category. A teacher's view of the nature of this technology has a major impact on the teaching and learning of science and technology education [6].

In the relationship between science and technology, students are given a statement that science and technology are closely interrelated. Based on the choice of answers as many as 46.43% of students are in the Has Merit category, they state that science is the basis of technology, but it is difficult to see how technology affects science. In the Realist category, there were 35.71% of students who explained the relationship between science and technology such as scientific research leading to practical applications in technology, and technological developments increasing the ability of scientific research. For the Naive category, 3.57% of students are in this category. Students see technology as the basis of scientific progress, but it is difficult to see how science can influence technology. For this sub aspect, there is a student who has difficulty determining her views on the relationship between science and technology. Linking science and technology is needed to see how differences in science and technology and at the same time will see how the contributions between science and technology affect each other [6,16].

3.2. Epistemology of Science
For the Epistemology aspect, science will look at the student’s point of view regarding the sub-aspects of the nature of the scientific model and the nature of the classification scheme. For the sub-aspects of the nature of scientific models, students are given a statement that many of the scientific models used in laboratory are copies of reality. Based on the answers of students who have a view of Realist category accounted for 28.57%. They revealed that the scientific model used was not the same as the original object because the model was only used to help explain something with all its limitations. In the Has Merit category, there are 50% of students in this category. They see the scientific model approaching the original object because it is based on scientific observation and investigation. While the other 21.42% is the Naive category. They assume that the scientific model is the same as the original object to show us the real object.

Meanwhile, for the aspect of the nature of the classification scheme, students are given statement that scientist do the classification based on the actual way in the nature, while other ways are wrong. The results showed mostly of students included Realists, amounting to 57.13%. They stated that there were many ways to classify things, but needed to be agreed upon by a universal system so as not to cause confusion. For the Has Merit category, only 3.57% of students stated that when scientists classify things in a simple and logical way, that does not mean that it is the only way. For the Naive category, 39.28% of students have this category. They think the classifications that scientists make follow what is actually in nature because they use characteristics that can be observed when making classifications. In addition, there are students who find it difficult to make choices because they do not have enough knowledge to define the nature of the classification scheme.

3.3. Internal Sociology of Science
In the third aspect, internal sociology of science, the sub-aspects that will be seen are scientific decisions and technological decisions. For sub-aspects of scientific decisions, students are given a statement when scientists will accept a new theory or not be based objectively on facts and are not influenced by personal subjectivity. In this sub-aspect as many as 60.65% of students have the category of Has Merit. There are two views on this category, first, they consider the decisions of scientists based on the facts observed and based on previous theories. This is like the results of the study that has been done on pre-service chemistry teachers in Turkey, they consider a hypothesis to be a theory which would later become a law based on the facts obtained [16]. In the Realist category, there is 32.14%, they assume that scientific decisions are based on whether the theory has been tested many times and no one has denied it. This result same as the result of a pre-service teacher test in Turkey, that is a scientific decision can change based on better facts or a reinterpretation of the previous facts [16]. While for the Naive category, there are two students who have this category or 7.1%, one student stated that she did not understand to
express her views on scientific decisions and the other felt that none of the choices were provided according to her views.

For the sub-aspects of technology decisions, the statement given is the decision to use new technology depends on whether the benefits to society outweigh their disadvantages. The majority of students in the Has Merit category which is 75%. They assume that in general the decision to use or not a technology is seen from its impact on humans, how it works, the price and efficiency of that technology. If the technology to be developed has many disadvantages, the technology will not be used. For the Realist category of 21.43%, according to the decision to use or not a technology depends on each person, because the good or bad view of a technology depends on the individual itself. For the Naive category of 3.57%, in this category students assume that many technologies developed are only for profit, although the adverse effects are more than the positive effects. In addition, there are students who choose views that do not have enough knowledge to make choices.

3.4. External Sociology of Science
In this last aspect, that is the relationship between science-technology-society. From the statement that science, technology and society are interrelated, 75% are in the Realist category. Eleven of the students chose the view of the relationship between science-technology-society, that on the one hand, science and technology influenced society but, on the other hand, society also influenced science and technology. Four students stated that the progress of a nation depends on the development of science and technology, science and technology rarely endanger human life and others state that to solve a problem is not only using science and technology. This is in accordance with the study conducted by Tairab, pre-service teachers show a Realist view that science and technology play a role in the prosperity of a nation [9]. For the Has Merit category of 21.43%, students revealed that the relationship between science-technology-society, namely science and technology innovation can cause environmental problems, while the views of other students, namely science and technology often make our lives healthier, easier and more comfortable. In the Naive category of 3.57%, the student felt that among the answer choices provided there was not one choice that was in accordance with his views.

The views of pre-service chemistry teacher regarding the nature of science and technology are generally of moderate ability. The six sub-aspects of NOST given are in the category of Has Merit, there are sub-aspects of the definition of science, the nature of scientific models, scientific decisions, the definition of technology, and technological decisions. As for the sub-aspects of the nature of the calcification scheme and the relationship of science-technology-society are in the category of Realists. One of the factors that cause insufficient views of pre-service teachers in the previous learning experience that is less steeped in the nature of science and technology [16]. For this reason, it is expected that in learning the teacher will also associate the nature of science and technology to justify the experience of students that have been obtained. To strengthen the pre-service chemistry teachers’ VNOST need to be designed a learning that will increase the understanding of pre-service chemistry teachers’ VNOST.

4. Conclusion
The results of the study show generally that the views on the nature of science and technology of pre-service chemistry teacher are in the category of Has Merit. Most pre-service chemistry teachers still have insufficient views on the nature of science and technology. In the definition of science and technology, students have no difficulty answering, and no one is in the Naive category. Most pre-service chemistry teachers define science as a body of knowledge, such as principles, laws, theories, which explain the world around us. This is slightly different from the research that Tairab has done. Most pre-service chemistry teachers define science as a field of science consisting of biology, chemistry, and physics [6]. For the definition of technology, most pre-service teachers define technology as the application of science that works to improve the quality of life. Pre-service teachers also explain the relationship between science and technology, that is scientific research leads to practical applications in technology, and technological developments enhance the ability to conduct scientific research. One way
that can be done to learn science and technology together with using techno science learning. Techno science is one approach in education that connects abstract conceptions and the physical world in cognitive design media [17].

In the sub-aspect of the nature of the scientific model, most pre-service chemistry teachers are in the category of Has Merit, they assume that the scientific model approaches the original object because it is based on observations and scientific investigations. Different results are shown in the sub-aspects of the nature of the classification scheme, most of the pre-service chemistry teachers are in the Realist category even though in the Naive category the presentation is also quite large. In general, the results of research conducted by [16] epistemological aspects of science include the nature of scientific models and the nature of classification schemes, a model can change based on better evidence or reinterpretation of previous evidence. For aspects of internal sociology of science, pre-service chemistry teachers are in the category of Has Merit. They explain scientific decisions based on what the previous theory and facts observed. Whereas for technology decision is based on their impact on society, how it works, the price, and efficiency. For the sub-aspects of science-technology-society relations, most pre-service chemistry teachers answer that on the one hand science and technology affect society, on the other hand, the community also influences science and technology, in accordance with the results of research conducted by Tairab [9]. This research will be used as a basis for developing didactic designs for pre-service chemistry teachers. Context used in learning is ionic liquids ad cellulose solvents.

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