Exploring View of Nature of Science and Technology Pre-Service Chemistry Teachers

Devita Marlina Venessa¹, Hernani², Heli Siti Halimatul²

¹Masters Program on Chemistry Education, Postgraduate School, Universitas Pendidikan Indonesia, Bandung, Indonesia
²Department of Chemistry Education, Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia, Bandung, Indonesia

*Corresponding Author. dy2psihite@gmail.com

ABSTRACT This study aims to explore the views of pre-service chemistry teachers on the nature of science and technology. Pre-service chemistry teachers' view of nature of science and technology (VNOST) is very important to help their students later in understanding the concepts of science. This research is the initial stage in didactical design research involving 48 pre-service chemistry teachers from Sriwijaya University. The descriptive method is used to explain the results of the analysis of pre-service chemistry teachers' VNOST. Student views were assessed using the VNOST questionnaire, consisting of 8 questions and guided by the discourse of ionic liquid technology. Data collection uses a survey containing the views of pre-service chemistry teachers on VNOST and where each statement grouped according to three categories, namely "Realistic" (R), "Has Merit" (HM), and Native (N). The results showed that in general, students have the view of Has Merit (HM), or the belief that they chose is not entirely correct even though there are parts of statements that are still by the general view of science. The results of this student VNOST exploration are the basis for developing learning designs that are oriented to the realist answers of each question so that learning designs are produced based on aspects of the Nature of Science and Technology.

Keywords View of nature of science and technology, Pre-service chemistry teachers, Nature of science, Kind of technology

1. INTRODUCTION

Science and technology are an influential part of developing scientific literacy abilities. Science literacy consists of several general dimensions, namely the nature of science, the kind of scientific knowledge, scientific concepts, scientific principles, and theories related to science (Shwartz, Ben-Zvi, & Hofstein, 2005). From some of the general dimensions of scientific literacy, it is widely believed that if a science teacher does not understand the Nature of Science and Technology (NOST), it will be challenging for them to assist their students in gaining a good understanding of scientific concepts (Murcia & Schibeci, 1999; Tairab, 2001; Ayvaci, & Ozbek, 2019). Science teachers' knowledge of the nature of science and technology is fundamental to prepare students to be able to participate in society with the development of science that is continuously changing scientifically and technology-oriented (Tairab, 2001). Besides, science teachers are also expected to be able to influence students in making the right decisions about the problems faced, especially in explaining phenomena related to science and technology (Rotherham, & Willingham, 2010; Tairab, 2001).

The importance of science teachers' understanding of NOST is related to the low results of the scientific literacy of students in Indonesia. Based on PISA data, measurements of the level of scientific literacy of Indonesian students in 2000-2015 are still far below the international average. The results of the 2015 Program for International Student Assessment (PISA) study show that Indonesia is 64th out of 72 countries. The results of students' scientific literacy mastery are arranged into seven levels from level 1b to level 6, where the higher the level, the better scientific literacy mastery. The position of Indonesian students is shown to be below level 1 by 1.2%; 14.4% at level 1b; 40.4% at level 1a; 31.7% at level 2; 10.6% at level 3; 1.6% at level 4; 0.1% at level 5 and none at level 6 (OECD, 2016). The data shows that the majority of Indonesian students still trapped below the second level of 87.7% and 41.6% of students are below level 1b. These results indicate that students in Indonesia are still difficult
Molten salt and ionic liquid are two groups of substances that are ionic compounds but both have differences in melting point. Molten salt generally has a high melting point. Table 1 shows the melting points of some Molten salts.

| Compound | Melting Point (°C) |
|----------|-------------------|
| NaNO₃    | 306.8             |
| KNO₃     | 333               |
| NaCl     | 801               |
| KCl      | 770               |
| CaCl₂    | 772               |

The high melting point of Molten salt causes the application as a heat transfer medium is limited to high temperatures. However, in the 19th century, chemists discovered a red liquid from the reaction of anhydrous aluminum chloride with amyl chloride. The scientists showed that the red liquid consisted of an arylated aromatic ring cation and a chloroalumminic anion (AlCl₄⁻) so it was called an ionic liquid. Likewise, in 1888, Gabriel discovered 2-Hydroxy ethane ammonium nitrate which had a melting point of 52°C-55°C. The discovery of 2-hydroxy ethane ammonium nitrate with a melting point below 100°C is the beginning of the term ionic liquid. The asymmetric structure of the ionic liquid makes this 'salt' unique and expands the application of 'salt' at low temperatures.

**Figure 1** Ionic liquid technology discourse

One example of molten salt is Sodium Chloride (NaCl) which melts at 801°C. NaCl is also known as salt or halite and is widely used as a raw material and chemical synthesis. NaCl is derived from Sodium which is shiny metal and chlorine which is a light green gas. Under exothermic conditions, when a small piece of sodium metal is melted in a metal spatula and mixing it with Chlorine in the flask will give a bright yellow light. A piece of heated sodium will run off with chlorine and produce a white powder, salt (NaCl). This white NaCl salt powder is a solid crystalline form composed of Na⁺ ions with balanced quantities of Cl⁻ ions. The arrangement of ions that very tightly affects the properties of NaCl crystals.

**Figure 2** Discourse on ionic formation process in NaCl

to identify and apply scientific concepts to the phenomena they have (Bybee & McCrae, 2011; Mudzakir, Widhiyanti, Arifin, Lestari, & Jauhariansyah, 2017).

Based on these facts, how a teacher views the nature of science and technology will influence what they choose to teach and how they will teach (Lederman, 1992; Mansour, 2010). As expressed by Tairab (2001), science teachers must work out better ways to improve students' understanding of the nature of science and technology. A science teacher needs to have adequate knowledge of science and technology because the views they hold on NOST will influence directly or indirectly in the way they present learning experiences in class (Palmquist & Finley, 1997; Tairab, 2001).

Based on this, research to explore how the views of science teachers to NOST needs to done and in this study, selected pre-service chemistry teachers as research subjects. Pre-service chemistry teachers chose because later, they would play an essential role in influencing students to be literate in science (Tairab, 2001; Lederman, Lederman, & Antink, 2013). Exploration The Pre-service chemistry teachers' VNOST is essential to know whether the understanding of Pre-service chemistry teachers about the nature of science and technology is adequate. The results of the exploration of the initial views of Pre-service chemistry teachers will be a follow-up to the next research in determining the right solution to develop the opinions of Pre-service chemistry teachers towards Realistic or get an adequate understanding of NOST.

Previous research to explore pre-service chemistry teachers 'views on the relationship between science and technology has been carried out by Mansour (2010), where educators' views on the relationship between science and technology scattered in the naïve, has merit and realistic categories. Initially educators have a naïve view or do not have an adequate understanding of Nature of Science and Technology (NOST), but with a change of view of Nature of Science and Technology (NOST) in the realist category provides a practical difference in the development of pedagogy and teaching of educators (Mansour, 2010).
Likewise research conducted by Kusuma, Mudzakir, & Widhiyanti (2019) where the views of Pre-service chemistry teachers are generally in the Has Merit category or statements that selected by pre-service chemistry teachers on the VNOST questionnaire are groups of reports that indicate conditions that are not entirely true even though there are parts of the statement that are still in accordance with the general view of science, scientific concepts, and scientific theories (Rubba & Harkness, 1993).

Based on the background stated, this study aims to explore the pre-service chemistry teachers' VNOST in looking at the nature of science and technology. Exploration of the views of pre-service chemistry teachers to NOST focuses on four aspects offered by Tairab (2001), namely the characteristics of science and technology, the purpose of science and scientific inquiry, the features of scientific knowledge, and scientific theory, and the relationship between science and technology. Exploration of the views of pre-service chemistry teachers uses the VNOST questionnaire adapted from Tairab (2001) but has modified by the addition of an ionic fluid technology-based discourse. Through the acquisition of the discussion of ionic liquid technology, pre-service chemistry teachers are expected to understand the relationship of the NOST context from the viewpoint of the latest philosophical and historical analysis of the scientific activities and practices of scientists in developing ionic liquids as triggers for technological development in the world.

2. METHOD

The descriptive method is used in this study to explain the results of an analysis of the views of pre-service chemistry teachers to NOST. Data collection techniques using the VNOST questionnaire which adapted from the journal "Views on Science-Technology Society ©" (Aikenhead, Ryan, & Fleming. 1989) and modified again by Tairab (2001) and then changed back by researchers by adding discourse on ionic liquid technology. Participants in this study were 48 pre-service chemistry teachers from the Chemistry Education Study Program at Sriwijaya University.

VNOST Questionnaire consists of 8 Questions / Statements in the form of 7 multiple choice and one essay. Seven multiple-choice items require students to choose a statement that fits their views while one essay item requires students to give their opinion in writing about the difference between science and technology. Data collected for seven multiple-choice questions were analyzed using a frequency distribution to characterize students' views of the nature of science and technology, while description questions regarding the general opinions of pre-service chemistry teachers' differences in science and technology described descriptively. The frequency distribution provides a characterization of the views held by pre-service chemistry teachers based on the categories suggested by Rubba & Harkness (1996). The results of pre-service chemistry teachers' VNOST for each question item categorized by the R / Realistic category (choice expresses
Table 1 Frequency and percentage of students’ views on what is science, its aim, and natural scientific research

| Statement                                                                 | Category | Frequency | %   |
|--------------------------------------------------------------------------|----------|-----------|-----|
| **Definition of Science**                                                |          |           |     |
| The development of the invention and application of liquid salt and    |          |           |     |
| ionic liquid technology is a scientific activity. In your opinion, basic |          |           |     |
| science is...                                                            |          |           |     |
| The fields of science, such as biology, chemistry, and physics.         | HM       | 3         | 6.25|
| Principles, laws, and theories, which explain the world around us such  | HM       | 35        | 72.9|
| as matter, energy, and life                                            |          |           |     |
| Investigate the unknown and discover new things about the world, the   | R        | 4         | 8.33|
| universe, and how it works.                                            |          |           |     |
| Involve experiments to solve problems around us.                        | HM       | 3         | 6.25|
| Create and designing things (for example, artificial hearts, computers,| N        |           |     |
| and space vehicles).                                                    |          |           |     |
| Find and using knowledge to make a better world (for example, cure     | HM       | 2         | 4.17|
| diseases, overcome pollution, and improve agriculture).                |          |           |     |
| A group of people called scientists who have ideas and techniques to   | N        |           |     |
| discover new knowledge.                                                |          |           |     |
| I do not know                                                           | N        | 1         | 2.08|
| I do not have enough knowledge to make a choice                         |          |           |     |
| **The Purpose of Science**                                              |          |           |     |
| The objectives of the Sainspembenionic NaCl from its elements have a   |          |           |     |
| purpose, as well as science. In your opinion, the purpose of science   |          |           |     |
| is...                                                                   |          |           |     |
| Believing that what has found about the world is an essential truth    | N        | 1         | 2.08|
| Understand, explain, and interpret ongoing changes in nature and its   | R        | 32        | 66.7|
| characteristics                                                         |          |           |     |
| Find, collect and classify facts about nature                           | HM       | 10        | 20.8|
| Discovering new ways to make life a better age                         | HM       | 3         | 6.25|
| I do not understand.                                                    | N        |           |     |
| I do not have enough knowledge to determine the choice.                 | N        |           |     |
| None of the above choices fit my view                                   | -        | 2         | 4.17|
| **Scientific research**                                                 |          |           |     |
| The activities undertaken by BRAGG and friends are a form of           |          |           |     |
| scientific research. Why do you think scientists do scientific research?|          |           |     |
| To create a new invention.                                             | N        |           |     |
| To test their explanation about why things can happen.                  | R        | 24        | 50  |
| To make something that can help human life.                             | HM       | 3         | 6.25|
| To collect as much data as possible, and conclude a scientific law     | HM       | 21        | 43.8|
| based on that data.                                                    |          |           |     |
| I do not understand.                                                    | N        |           |     |
| I do not have enough knowledge to determine the choice.                 | N        |           |     |
| None of the above choices fit my view                                   | -        |           |     |
| Notice: HM: Has Merit, R = Realistic, N = Naive                         |          |           |     |

as an appropriate view), HM / Has Merit (option is not realistic, but shows a legitimate thing), N / Naive (decision shows ideas that are not correct/invalid) and Uncategorized (choices that reveal that none of the options in items 1-7 are in accordance with the views of pre-service chemistry teachers (Rubba & Harkness, 1996).

3. RESULT AND DISCUSSION

The view held by pre-service chemistry teachers about the Nature of Science And Technology (NOST) is presented in the I – IV table. Results pre-service chemistry teachers’ VNOST grouped by 4 categories, namely (1) on the table I I offered the view of pre-service chemistry teachers to the scientific definition of science, the purpose of science and the fact of the scholarly research, (2) on the table II presented views pre-service chemistry teachers about...
Table 2: Frequency and percentage of students’ views on the nature of scientific knowledge and scientific theory

| Statement                                                                 | Category | Frequency | %   |
|---------------------------------------------------------------------------|----------|-----------|-----|
| Scientific Knowledge                                                      |          |           |     |
| Investigation of the melting point of ionic liquids yields scientific knowledge. In your opinion, the following statement is following your understanding of scientific knowledge? |          |           |     |
| Scientific knowledge is a collection of well-organized facts.             | R        | 21        | 43.8|
| Current scientific knowledge based on scientific perspectives, ideas, and interpretations of scientists from the past. | R        | 26        | 54.2|
| Scientific knowledge was at one time produced by scientists at that time. | HM       |           |     |
| Scientific knowledge only contains statements that are 100% true.         | N        | 1         | 2.08|
| I do not understand.                                                       | N        | 24        | 50.00|
| I do not have enough knowledge to make a choice                           | N        | 1         | 2.08|
| None of the above options are in line with my view                         | -        | 3         | 6.25|
| Scientific Theory                                                         |          |           |     |
| Based on the discourse above, in your opinion, a scientific theory is...   |          |           |     |
| An idea of what will happen                                                | N        | 13        | 27.08|
| The most appropriate interpretation and explanation which has been agreed by scientists | HM       |           |     |
| A fact that has proven through various experiments                        | R        | 21        | 43.8|
| I do not have enough knowledge to make a choice                           | N        | 1         | 2.08|
| I do not understand                                                       | N        | 1         | 2.08|
| There is no one choice above that fits my point of view                    | -        | 4         | 8.33|

*Notice: HM : Has Merit, R = Realistic, N = Naive*

scientific knowledge and scientific theory, (3) on table III presented the picture of pre-service chemistry teachers about technological characteristics and the relationship between science and Technology, (4) on table IV gave a general view pre-service chemistry teachers about the differences in science and technology.

The results of the student views of chemical teachers on the definition of science, science objectives, and the nature of scientific research presented in Table 1. Based on table 1, only 8.33% of pre-service chemistry teachers choose the science definition statement is investigating the unknown and discovering new things about the world, the universe as well as how it works. This view is considered *Realistic* by Rubba and Harkness (1993). Science as an investigation process also stated by scientists compiled by Tairab (2001), stating that science is a tool to explain the world. Similarly, the opinions expressed by Me Ginn (1991) where science is an organized body of knowledge and is a systematic field of investigation into nature. However, based on the results of grouping of categories corresponding to the Rubba & Harkness (1993) of the statements selected by pre-service chemistry teachers, generally or about 72.9% of pre-service chemistry teachers choose the statement that science is a knowledge, like principle, law, and theory, which explains the world around us (matter, energy, and life). The statement categorized into the *Has Merit* category or comment with the condition that is not entirely correct, but there is part of the report still by the general view of science, the concept of science, and the theory of science (Rubba & Harkness, 1993).

As discussed earlier, the VNOST questionnaire given to pre-service chemistry teachers guided by the technological discourse of ionic liquid (Figure 1). Speech given by presenting the melting point data of liquid salt and research on the ionic liquid should be able to affect the pre-service chemistry teachers to choose the statement that science is the process of investigating the unknown and discover new things about the world and the universe. However, the sheer view of pre-service chemistry teachers on the statement suggests that so far, they think that the principles, laws, and theories expressed by previous scientists are at the heart of the science's characteristics. Epistemological science, where science is a way to know or constitute the values and beliefs inherent in the development of scientific knowledge (Lederman, 1992; Lederman, Laderman, & Antink, 2013) poorly understood by pre-service chemistry teachers as a whole. Also, the learning experienced by pre-service chemistry teachers who are more likely to memorize and receive confidently all scientific explanations obtained from teaching materials or classes of instruction can potentially affect the view them to science. Pre-service chemistry teachers rarely make direct connections or investigate things around them where principles, laws, and theories should be used to explain the unknown so that they can tell the phenomena they observe or can build new knowledge that can complement the experience developed by previous scientists. As revealed by Fernandes, Rodrigues, & Ferreira, (2018) that an understanding of the nature of science evolved the time they became students and remained constant for many years, making it very difficult to reduce previous perceptions held by pre-service chemistry teachers about science.
Table 3 Frequency percentage of students’ views on the definition of technology and the relationship between science-technology

| Statement                                                                 | K   | F  | %  |
|---------------------------------------------------------------------------|-----|----|----|
| **Definition of Technology**                                              |     |    |    |
| Ionic liquids are an opportunity for environmentally friendly technology.  |      |    |    |
| Application of science that is useful to improve the quality of life of   | HM  | 19 | 39.6 |
| Various objects made by humans such as devices, tools, and instruments    | R   | 10 | 20.8 |
| objects, techniques, processes, and people related to HM devices, tools   | HM  | 3  | 6.25 |
| and instruments                                                         | R   | 13 | 27.1 |
| Creating, designing, developing and testing devices, tools, and instruments |    |    |    |
| Very similar to science                                                  | N   |    |    |
| The process of producing and knowing how to make a product               | N   | 1  | 2.08 |
| I don't understand                                                       | N   |    |    |
| I don't have enough knowledge to make N choices                          | N   |    |    |
| There is no one choice above that fits my point of view                   | -   | 2  | 4.17 |

**The Relationship Between Science and Technology**

| From the explanation above, science and technology interrelated with daily life. In your opinion, the statement below that fits your understanding is |     |    |    |
|-----------------------------------------------------------------------------------------------------------------------------------|-----|----|----|
| Technological innovation and / or science development can cause environmental problems                                         | HM  | 4  | 8.33 |
| Science and technology often make our lives healthier, easier, and more comfortable                                              | HM  | 4  | 8.33 |
| The prosperity of a nation depends on the extent of the development of science and technology.                                      | HM  | 10 | 20.83 |
| Science and technology rarely endanger human life.                                                                                | N   |    |    |
| We cannot solve all the problems we face using only science and technology.                                                        | R   | 3  | 6.25 |
| Because science, technology, and society are not related to one another, they do not influence each other.                      | N   | 1  | 2.08 |
| On the one hand, science and technology affect society, but on the other hand, society also influences the development of science and technology. | R   | 19 | 39.6 |
| I do not know.                                                                                                                     | N   | 4  | 8.33 |
| I do not have enough knowledge to make a choice.                                                                                  | N   | 1  | 2.08 |
| There is no one choice above that fits my point of view                                                                          | -   | 2  | 4.17 |

*Notice : HM : Has Merit, R = Realistic, N = Naive*

Unlike the case with the goals of science, pre-service chemistry teachers generally have a realistic view. 66.67% of the total number of students chose the statement that the purpose of science is to understand, explain, and interpret sustainable changes in nature and their characteristics. The results of this study also show the same thing as the research conducted by Lokollo, Hernani, & Mudzakir (2019) wherein science goals, 44.1% of pre-service chemistry teachers have a realistic view. Likewise, a study conducted by Kusuma, Mudzakir, & Widhiyanti (2019) in which 70.73% of pre-service chemistry teachers had a practical perspective. In this section, there is a change that is better than the first view of students regarding the definition of science, which was previously in the Has Merit category. However, as many as 20.8% of the number of pre-service chemistry teachers consider that the purpose of science is to discover, gather, and classify facts about nature and find new ways to make human life right. This view categorized into Has Merit, or the statement they choose contains part of the report, which is process-oriented and still by the purpose of science.

The discourse given regarding the phenomenon of the process of forming ionic salts, as shown in Figure 2, can guide pre-service chemistry teachers to understand that science aims to understand, explain, and interpret sustainable changes in nature and their characteristics. If this view is related to the opinions of pre-service chemistry teachers regarding the definition of science, it can conclude that pre-service chemistry teachers believe that knowledge such as principles, laws, and theories are the main characteristics of science. Pre-service chemistry teachers do not understand that experience in the form of policies, rules, and methods constructed by previous scientists is a way for scientists to explain the results of their investigation of the world and the universe. Likewise, the views of pre-service chemistry teachers for the nature of scientific research evenly distributed in the Realistic and Has merit categories. Half of the students think that scientists conduct scientific research to test their explanations of why things can happen. This view categorized in Realistic (R). The student choice of the statement is by the general opinion of science, where the primary purpose of scientific research is to gather the knowledge needed to compile an explanation of phenomena that exist in the world through specific rules (Tairab, 2001). However, half of the pre-service chemistry teachers chose the statement that scientists conduct scientific research to make something that can help human life and collect as much data as possible and conclude a scientific law based on that data. The students’ views are categorized in Has Merit and show that they believe scientific research is related to social aspects. Students
think that scientific research is needed to produce a product that can use for the needs of many people.

The view of pre-service chemistry teachers in the Häi Merit category shows that they have an inadequate look at scientific research. Although the discourse gives (Figure 3) presents one example of a study conducted by scientists to test their explanation of the structure of NaCl, but the learning process, teaching methods, and their learning methods generally through memorization may be the cause of inadequate views of pre-service chemistry teachers towards scientific research. Of course, it would be difficult for pre-service chemistry teachers to influence later students' ability to view science.

In Table 2, students' views on the nature of scientific knowledge generally distributed in the realistic category. 98% of students have an understanding that scientific knowledge is a well-organized collection of facts and based on scientific perspectives, ideas, and interpretations of scientists from the past. The majority of students have a realistic view and show that they have an understanding by scientists where scientific knowledge is a collection of knowledge obtained through scientific research compiled through certain scientific principles. However, 2.08% of students are naïve and think that scientific knowledge only contains statements that are 100% true.

Unlike the case with scientific theory, in general, students' views of the scientific method are spread in the realistic category, where 50% of students consider that scientific method is a fact that has proven through various experiments. 27.08% of students choose the statement that scientific theory is the most appropriate interpretation and explanation, which has been agreed by scientists and this view categorized into Häi Merit. Both comments still show an opinion by the light of scientists where scientific theory is the simplest explanation of a phenomenon that can prove through a series of experiments (Tairab, 2001). However, 14.58% of students have a naïve view. Students assume that scientific theory is an idea of what will happen. Also, students do not have enough knowledge to determine their choices and do not understand. The fact "no knowledge or no understanding" proves that some pre-service chemistry teachers are less sure about their choice of scientific theory. 8.33% of students choose "there is no choice that fits my point of view." shows that students have
other views about scientific methods but not revealed when filling out the VNOST questionnaire.

The results of pre-service chemistry teachers’ VNOST regarding technology and the relationship between science and technology shown in Table 3. In Table 3, the views of pre-service chemistry teachers on the definition of technology generally scattered in the realistic category that is equal to 47.9%. Pre-service chemistry teachers assume that technology is a variety of objects made by humans, such as devices, tools, and instruments (e.g., computers). This view shows that students believe that technology is all forms of objects that are used to facilitate human life. The majority of pre-service chemistry teachers choose technology as a tool and instrument by the estimation of Gardner (1999), where most people tend to believe that technology is the application of science in the form of useful products to serve humanity. Also, students’ realistic views focused on the definition of technology is creating, designing, developing, and testing devices, tools, and instruments. This view is consistent with the opinion of the general public, where technology is an application of science. It is in line with research conducted by Tairab (2001), where students believe that technology is an artifact such as equipment, tools, and materials used to make certain types of techniques.

Although technology is identical to tools and instruments, the assumption that technology influences the quality of human life also chosen by some students (45.9%) who categorized in Has Merit. The student's view shows that technology developed as a social goal for the welfare of social life. It is a concern expressed by Aikenhead & Ryan (1992), where tools or so-called instrumentalists often confuse science in terms of technology, especially those relating to their social goals. The statement chosen by pre-service chemistry teachers that technology is the application of science that is useful for improving the quality of life shows that they agree with things like devices, tools, and instruments that engineered are examples of technology. They assume that technology is the application of science. It is also consistent with the view of Gardiner (1999), where technology generally is seen as a science application. However, it needs to understand that technology is not only an application of science, but technology creates objects to be investigated and sometimes technological innovation is a direct goal of research (Lacey, 2012). Besides, 2.08% of students consider that technology is a process for producing and knowing how to make products. This view is Naïve. Students do not understand that the outcome demonstrates that the technique is not a step or process that is done to produce something.

Likewise, when students asked to choose their understanding of the relationship between science and technology, as many as 45.38% of the number of students want that on the one hand, science and technology affect society, on the other hand, culture also influences the development of science and technology. This view categorized as Realistic. Students display the belief that science and technology have an impact on society and that the effect depends on how to use science and technology itself. These results prove that pre-service chemistry teachers agree that science and technology are two parts that are not mutually exclusive and mutually reinforcing. Science and technology are two different, but interconnected and inseparable subjects. Science and technology are involved in complex and interactive two-way interactions, as revealed by Gardner (1999).

On the other hand some of the views of pre-service chemistry teachers about the relationship between science and technology are categorized into Has Merit which is detailed as follows, (1) 8.33% of students choose technological innovation and/or science development can cause environmental problems, (2) 8.33% of students select science and technology often makes our lives healthier, easier and more comfortable, (3) 20.83% of students choose the prosperity of a nation depends on the rapid development of science and technology. This choice, although not realistic, reveals a valid statement about the nature of science, technology and its interactions in society. These results indicate that students agree with the view that technology does indeed influence society. It is consistent with the belief that reveals that technology is intricately woven in human activities and is influenced or influences human capabilities, cultural values, public policies, and environmental constraints (Herman, 2013).

On the other hand, 12.49% of the number of students have a naïve view. Students consider science, technology, and society not related to one another so that they do not influence each other. They also choose "do not know" and do not have enough knowledge to make a choice. These results indicate that students who consider science and technology to be independent and unrelated. This view is not by the opinions of Gardner (1999), where technology and science are involved in two-way and interrelated interactions. Pre-service chemistry teachers seem less aware that technological developments that have an impact on society are closely related to science.

Meanwhile, scientists agree on the science, science resolution, goal science, scientific research, exact science, scientific theory, technological fission, and the relationship between science and technology discussed in Figure 4.

The results of the VNOST questionnaire for the 8th item about the views of pre-service chemistry teachers about the differences in science and technology described descriptively shown in Table 4. Based on the opinions expressed by pre-service chemistry teachers about the differences in science and technology, science generally regarded as knowledge, thought, analysis, science, and a process of understanding while technology considered as the application of science, devices, information sections,
scientific products and a breakthrough from science. The views of pre-service chemistry teachers are not entirely by the general look of science where science is an organized body of knowledge and is a field of systematic inquiry into nature while technology is everything that is used to facilitate human life. Therefore, students' understanding of science and technology needs to be developed to be adequate in a more realistic direction.

4. CONCLUSION
This study explores the views of pre-service chemistry teachers on the Nature of Science and Technology (NOST). The research findings show that students' views generally scattered in the Realistic and Has Merit categories. Regarding the specific aspects of science and technology, students' pictures show the opposite results. The look of the definition of science, generally spread in the Has Merit category while for the meaning of technology is usually covered in the Realist category. The results with these two different categories show that students are less confident in the definition of science as a tool to explain phenomena. However, it is different from the description of technology where students believe that technology is everything that is used to facilitate human life. These findings indicate that pre-service chemistry teachers used to deal with a variety of technological innovations, but they are difficult to connect the interrelationships of science and technology in them. Therefore, the nature of science and technology needs to be explicitly discussed and discussed so that pre-service chemistry teachers can later develop an appropriate view of the characteristics of science and technology.

Other findings on the specific aspects of scientific knowledge and scientific theory show that students' views generally scattered in the realistic category. Almost all students believe that scientific knowledge is a collection of knowledge obtained through scientific research compiled through specific rules. On the other hand, half of the students believe that scientific theory is the simplest explanation of a phenomenon that can prove through a series of experiments.

In the aspect of the objectives of science and scientific research, students' views generally spread in the realistic category. Students believe that the purpose of science is process-oriented to explain a phenomenon that proven through scientific research. So it is with aspects of the relationship between science and technology. In general, students' views spread in the realistic category. Students agree that science and technology are two different subjects but related in two directions, where, on one side, science requires technology, and on the other hand, the technique involves science. Also, their views prove that science and technology are closely related and significantly affect people's lives.

In general, it can conclude that the results of the View of Nature of Science and Technology (VOST) pre-service chemistry teachers are in the Has Merit category where the statements they choose about the nature of science and technology are only partially consistent with the general view of science. These results prove that although pre-service chemistry teachers have been given a discourse in the form of an ionic liquid phenomenon, their lights have not yet led to Realistic. Therefore, the results of the opinions of pre-service chemistry teachers who participated in this study had a significant influence on the teaching and learning of students' science. An adequate understanding of NOST is an urgent basis at all levels in science education (Tairab, 2001). By understanding the nature of science and technology, pre-service chemistry teachers can understand the phenomena that occur in their environment and can relate them to the concept of science as a whole. If a science teacher's view of the nature of science reflected in his pursuit, then that view will have a significant impact on the teaching and learning that they do.

ACKNOWLEDGMENT
The authors acknowledge members of the chemical curriculum content innovation field who participated in giving ideas and suggestions for improving this article.

REFERENCES
Aikenhead, G. S., Ryan, A. G., & Fleming, R. W. (1989). Views on science-technology-society. Social Science and Humanities Research Council. Aikenhead, G. S., & Ryan, A. G. (1992). The development of a new instrument: Views on Science—Technology—Society (VOSTS). Science education, 76(5), 477-491.
Ayvaci, H. S., & Ozbek, D. (2019). The Effect of Documentary Films on Preservice Science Teachers’ Views of Nature of Science. Journal of Science Learning, 2(3), 97-107.
Bybee, R., & McCrae, B. (2011). Scientific literacy and student attitudes: Perspectives from PISA 2006 science. International Journal of Science Education, 33(1), 7-26.
Fernandes, G. W. R., Rodrigues, A. M., & Ferreira, C. A. (2018). Conceptions of the nature of science and technology: a study with children and youths in a non-formal science and technology education setting. Research in Science Education, 48(5), 1071-1106.

DOI: 10.17509/jsl.v3i1.17757
Gardner, P. L. (1999). The representation of science-technology relationships in Canadian physics textbooks. *International Journal of Science Education, 21*(3), 329-347.

Herman, B. C. (2013). A convergence of Postman and Vygotsky perspectives regarding contemporary media’s impact on learning and teaching. *The nature of technology* (pp. 291-328). Brill Sense.

Kusuma, D. C., Mudzakir, A., & Widhiyanti, T. (2019). Pre-service chemistry teachers’ VNOST and their conceptions about the context of OLED and related chemistry contents. In *Journal of Physics: Conference Series* (Vol. 1157, No. 4, p. 042037). IOP Publishing.

Lacey, H. (2012). Reflections on science and technoscience. *Scientiae studia, 10*(SPE), 103-128.

Lederman, N. G. (1992). Students' and teachers' conceptions of the nature of science: A review of the research. *Journal of research in science teaching, 29*(4), 331-359.

Lederman, N. G., Lederman, J. S., & Antink, A. (2013). Nature of science and scientific inquiry as contexts for the learning of science and achievement of scientific literacy. *International Journal of Education in Mathematics Science and Technology, 1*(3), 138-147.

Lokollo, L., Hernani, H., & Mudzakir, A. (2019). Pre-service chemistry teacher’s view about the nature of science and technology. In *Journal of Physics: Conference Series* (Vol. 1157, No. 4, p. 042036). IOP Publishing.

Mansour, N. (2010). Science teachers’ perspectives on science-technology-society (STS) in science education. *Eurasian Journal of Physics and Chemistry Education, 2*(2), 123-157.

Mc Ginn, R. E. (1991). *Science and technology, and society* (No. 303.483 M4599s EJ 1). Prentice Hall.

Mudzakir, A., Widhiyanti, T., Hernani, Arifin, M., Lestari, A. N., & Jauhariansyah, S. (2017, August). The nature of science and technology for pre-service chemistry teacher: A case of technology experiment “From Stannum Metaliicum to conductive glass.” In *AIP Conference Proceedings* (Vol. 1868, No. 1, p. 030015). AIP Publishing.

Murcia, K., & Schibeci, R. (1999). Primary student teachers' conceptions of the nature of science. *International journal of science education, 21*(11), 1123-1140.

OECD, P. (2016). Results (Volume I): Excellence and equity in education.

Palmquist, B. C., & Finley, F. N. (1997). Preservice teachers' views of the nature of science during a postbaccalaureate science teaching program. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 34*(6), 595-615.

Rotherham, A., & Willingham, D. (2010). New, but a Worthy Challenge. *American Educator, 17*-20.

Rubba, P. A., & Harkness, W. J. (1996). A new scoring procedure for the Views on Science-Technology-Society instrument. *International Journal of Science Education, 18*(4), 387-400.

Shwartz, Y., Ben-Zvi, R., & Hofstein, A. (2005). The importance of involving high-school chemistry teachers in the process of defining the operational meaning of 'chemical literacy.' *International Journal of Science Education, 27*(3), 323-344.

Tairab, H. H. (2001). How do pre-service and in-service science teachers view the nature of science and technology?. *Research in Science & Technological Education, 19*(2), 235-250.