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

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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 *Naïve* (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

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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.

Tabel 1. The Melting Point of Molten Salt

Compound	Melting Point (°C)
$NaNO_3$	306,8
KNO_3	333
NaCl	801
KCl	770
$CaCl_2$	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 chloroaluminic anion ($AlCl_4^-$) 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 r*ealistic* 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).

The structure of molten salt has been studied through the invention of optical microscopy and developed rapidly after the discovery of X-rays. With X-ray diffraction, in 1993, the determination of the structure of solid sodium chloride solid was successfully carried out by William Henry Bragg and William Lawrence Bragg. Through X-ray diffraction, the arrangement of ions and the crystal structure can be determined. The results of X-ray diffraction are shown in Figure 1.

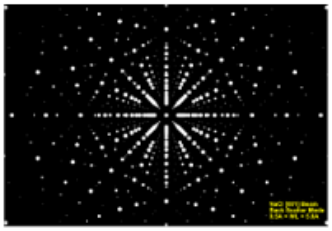

Figure 1. X-ray diffraction pattern on NaCl crystals.

Bragg et al also determined the relative configuration of ions and the distance between ions. Based on Bragg's discovery, in solid sodium chloride there are actually no "molecules" of Sodium Chloride but instead, are made up of ions. Until now, this NaCl molten salt has been known to consist of simple anions and cations that are efficiently packaged and, therefore, have high lattice energy that affects the physical properties of these compounds. The structure and properties of crystalline solids, such as melting points, densities, and hardness are determined by the electrostatic attraction forces that bind these particles.

Figure 3 Discourse on the determination of NaCl structure by x-ray diffraction

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 as matter, energy, and life	HM	35	72.9
Investigate the unknown and discover new things about the world, the universe, and how it works.	R	4	8.33
Involve experiments to solve problems around us.	HM	3	6.25
Create and designing things (for example, artificial hearts, computers, and space vehicles).	N		
Find and using knowledge to make a better world (for example, cure diseases, overcome pollution, and improve agriculture).	HM	2	4.17
A group of people called scientists who have ideas and techniques to discover new knowledge.	N		
I do not know	N	1	2.08
I do not have enough knowledge to make a choice	N		
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 characteristics	R	32	66.7
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 based on that data.	HM	21	43.8
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

an appropriate view), HM / *Has Merit* (option is not realistic, but shows a legitimate thing), N / *Naïve* (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 Technolgy (NOST) is presented in the I – IV table. Results pre-service chemistry teachers' VNOST grouped by 4 categories, namely (1) on the table 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		
I do not understand.	N	1	2.08
I do not have enough knowledge to make a choice	N		
None of the above options are in line with my view	-		
Scientific Theory			
Based on the discourse above, in your opinion, a scientific theory is...			
An idea of what will happen	N	3	6.25
The most appropriate interpretation and explanation which has been agreed by scientists	HM	13	27.08
A fact that has proven through various experiments	R	24	50.00
I do not have enough knowledge to make a choice	N	1	2.08
I do not understand	N	3	6.25
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 Mc 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. In your opinion, what is meant by 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 (e.g. computers)	R	10	20.8
objects, techniques, processes, and people related to HM devices, tools and instruments	HM	3	6.25
Creating, designing, developing and testing devices, tools, and instruments	R	13	27.1
Very similar to science	N		
The process of producing and knowing how to make a product	N	1	2.08
I do not 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

Table 4 Pre-service chemistry teachers prospects views of differences in science and technology

No	Science	Technology
1	A rational, systematic, logical, and consistent process of thought and analysis	Part of the set of information included in scientific knowledge, containing perspective information regarding the creation of systems and their operation
2	A knowledge that uses in everyday life	The application of science is made to improve the quality of life
3	The study of life on earth and the research and resolution of problems by experimentation and analysis	Devices that are run with or without human assistance and are useful to help work and observe things that humans have not been able to achieve. Example: Microscope, etc.
4	The study of nature, conscious efforts to investigate, discover and enhance human understanding of the reality of life	Various objects made by humans such as devices that can help humans to find information and knowledge
5	Science-based on collecting data, developing a theory and establishing a theory that can explain natural phenomena that occur scientifically.	Discovery, development, testing, and determination of tools or instruments that can be used in scientific activities scientifically.
6	Something that is already in and investigated for its truth through specific knowledge and a process of discovery	Human skills using natural resources through rational methods to be applied
7	A process of understanding or opinion about something that developed and logical, natural knowledge	Prescriptive information about system creation and operation
8	Natural knowledge developed	The result of developed natural knowledge
9	Knowledge or knowledge learning regarding aspects related to tools	Knowledge or knowledge learning regarding aspects related to tools.
10	A science or understanding that studies about life in nature that can be associated with everyday life.	A breakthrough in developing a knowledge that will bring new understanding to develop further
11	The basis of the embodiment of technology is absolute and scientific. Following what data is there and is a science-based on facts	The results of science or the application of scientific innovations that can support/facilitate life
12	Science is more focused on the concept of science and scientific facts that occur. Science of knowledge that continues to develop	Technology is more a product of science/science and also the development of previous concepts. Technology is more towards developing better
13	The process of thinking and analysis is rational, systematic, logical and consistent	Technology is part of the information included in scientific knowledge, which follows the path of the times.

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 *Has 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 *Has 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 chose "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 Gardner (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,

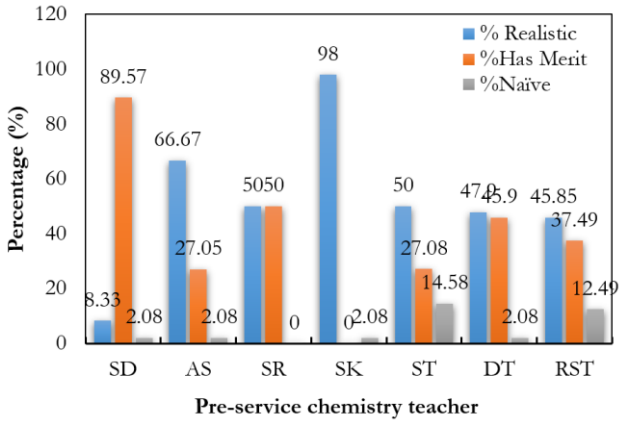

Figure 4 Percentage of views of pre-service chemistry teachers on NOST aspect

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 (VNOST) 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 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.

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