Investigating pre-service chemistry teachers’ view of the nature of science and technology for organic light-emitting diodes learning

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Abstract. This study aims to investigate the pre-service chemistry teachers’ (PCTs’) views of the nature of science and technology (VNOST) for organic light-emitting diodes (OLED) learning. VNOST is used to explain the phenomena of science and technology, and to explore the relation of science, technology, and society. It was proposed that the investigation of teachers’ VNOST is critical to improve the effectiveness of classroom learning. OLED technology is one of the newest technology that contained application of chemistry concepts and VNOST aspects, hence can be used in chemistry learning. The quantitative method was used in this study. The participants were 86 pre-service chemistry teachers (PCTs) at Universitas Negeri Padang (UNP) and Universitas Pendidikan Indonesia (UPI). The investigation of VNOST used a questionnaire from Aikenhead, consisted of eight questions. The PCTs’ VNOST was classified into three categories, namely: realistic (R), has merit (HM), and naïve (N). The results showed that there were many PCTs VNOST that categorized in HM and N categories. Identification of chemical concepts related to OLED suggested that OLED may be used in chemistry learning.

1. Introduction

Many educators agreed that the integration of science and technology in the classroom is very important to do because those are closely related to each other [1-3]. NOST is characteristic of specific constructions in the process of building science and technology knowledge [4]. An understanding of NOST will help teachers to develop their scientific inquiry skills, technology design, and metacognitive knowledge, so they can be more effective in their work and be more capable in decision making [5]. A way to integrate both science and technology is through technoscience education [6]. Technoscience education is a way to guide these science teachers to develop an understanding of how close the relationship between science and technology [2]. According to some educational researchers, science teachers should highly learn about how scientists and technologists think thinking framework [7]. This can also be applied to the field of chemistry. For that
reason, it will need a design of technochemistry education which includes technology used around the PCTs’ environment [8].

The course designed based on the understanding of the pre-service teacher about chemistry and technology. The content of the course should be chosen from the technology which can be found near to the pre-service teacher, such as organic light-emitting diodes (OLED). OLED technology is one of the newest technology that has some chemistry concept. OLED uses an organic compound that has the ability to emitting light while applied by electrical current [9]. OLED is a lighting technology that offers more efficient use of energy, because of its compact and thin shape. This technology can be used as a display panel [10]. OLED use for an alternative screen, which is considered more promising [11]. This technology pretty fascinating, since it enlarges applications from daily needs to scientific needs, such as smartphone display, biochemical sensor light, area lighting panel, and microdisplay [12-15]. OLED is used because it is one of the latest technologies that has several chemical concepts and can be related to NOST aspects. Each sub-aspect of NOST is associated with chemical concepts related to OLED.

Previous research believes that PCTs understanding of the NOST is still inadequate in several countries [1, 9, 12-18]. Correlated research has been conducted in Indonesia showing that some pre-service teachers have a naive view of the nature of the science and technology (VNOST) [19], while the views of teachers about NOST will affect their understanding in science [20]. Therefore, it is very interesting to investigate the PCTs’ views of the NOST and used it to suggest OLED learning for developing the understanding of NOST.

2. Methods
The quantitative method was used to assembly the understanding of PCTs’ VNOST, and to analyze the chemistry concepts that related to OLED. The participants were 86 PCTs at Universitas Negeri Padang (UNP) and Universitas Pendidikan Indonesia (UPI). The Participants consisted of 8th semester students (N=7), 6th semester students (N=78), and 4th semester student (N=1). The instrument used was adapted from the views on science-technology-society questionnaire which has tested its reliability and validity [21]. The questionnaire consists of 114 statements but only 8 statements use in this study which is related to the purpose of the study. The statement was translated into Bahasa and validated by experts. The VNOST aspects and sub-aspects can be seen in Table 1 [21]. The data obtained were analyzed using the frequency distribution of each sub-aspects and categorized into three categories, they are:

1. Realistic (R) express an appropriate view about science and technology
2. Has merit (HM) express the partly appropriate view about science and technology
3. Naïve (N) express an inappropriate view about science and technology [22, 23].

The analysis of chemistry concept related to OLED use several books and journals which explained about OLED [12, 24-26]. From those texts, then we can conclude some chemistry concepts related to OLED.

3. Result and discussion
This study is to investigate PCTs’ VNOST that shown in Figure 1 and Table 1. Many PCTs were classified into R category in five NOST sub-aspects (the interdependence of science and technology, the nature of scientific models, the nature of the classification scheme, scientific decisions and the relationship between science, technology and society), into HM category in three NOST sub-aspects (defining science, defining technology, and technological decisions).
Table 1. The percentage of PCTs’ VNOST

| NOST Aspects                  | NOST Sub-aspects          | VNOT Questionnaire Statements                                      | Percentage |
|-------------------------------|---------------------------|---------------------------------------------------------------------|------------|
|                               |                           |                                                                     | R         |
| Definition science and technology | 1. Defining science       | Science is….                                                       | 20.93     |
|                               |                           | Technology is….                                                    | 77.91     |
|                               |                           |                                                                     | 1.16      |
|                               | 2. Defining technology    |                                                                     | 17.44     |
|                               |                           |                                                                     | 79.07     |
|                               |                           |                                                                     | 3.49      |
|                               | 3. Interdependence of science and technology | The relationship between science and technology is… | 65.12     |
|                               |                           |                                                                     | 20.93     |
|                               |                           |                                                                     | 13.95     |
| Epistemology of science       | 4. Nature of scientific models | Many scientific models (for example models of atom) has characteristic… | 53.49     |
|                               |                           |                                                                     | 40.7      |
|                               |                           |                                                                     | 5.81      |
|                               | 5. Nature of classification schemes | Scientists classify something (for example elements in periodic table) according to… | 47.67     |
|                               |                           |                                                                     | 11.63     |
|                               |                           |                                                                     | 40.7      |
| Internal sociology of science | 6. Scientific decisions | How do scientists decide that a theory or model in science is acceptable or not? | 67.44     |
|                               |                           |                                                                     | 31.4      |
|                               |                           |                                                                     | 1.16      |
|                               | 7. Technological decisions | When a new technology is developed, it may or may not be put into practice. The decision to use a new technology depends on… | 26.74     |
|                               |                           |                                                                     | 63.35     |
|                               |                           |                                                                     | 9.3       |
| External sociology of science | 8. The relationship between science, technology, and society | The relationship between science, technology, and society is… | 69.77     |
|                               |                           |                                                                     | 9.3       |
|                               |                           |                                                                     | 20.93     |
|                               | Average                   |                                                                     | 46.11     |
|                               |                           |                                                                     | 41.82     |
|                               |                           |                                                                     | 12.07     |

Figure 1. PCTs’ VNOST
In defining science sub-aspect, most of the PCTs choose a statement that defining science as a body of knowledge such as principles, laws, and theory, which explains the world around us (in HM category). The PCTs should understand that science is exploring the unknown and discovering new things about our world and universe and how they work and carrying out experiments to solve problems of interest in the world around us. In definition of technology sub-aspect, most of the PCTs choose statement that defining technology as the application of science that is useful to improve the quality of life (in HM category). The definition of technology should be the process of creating, designing, developing and testing devices, tools, and instruments. In interdependence of science and technology sub-aspect, most of the PCTs have an appropriate statement about the relationship between science and technology. The interdependence of science and technology should be stated as scientific research leads to practical applications in technology, and technological developments enhance the ability to conduct scientific research.

In the nature of scientific models sub-aspect, most of the PCTs are in R category but the majority of the PCTs choose the statement that the scientific model approaching the original object because it is based on scientific observation and investigation. They assume that the scientific model is the same as the original object to show us the real object (in HM category). The scientific model should not be the same as the original object because the model is only used to help explain something with all its limitations. In the nature of the classification scheme sub-aspect, most of PCTs are in R category but majority of the PCTs choose the statement that scientists use characteristics that can be observed to classify something and according to nature (in N category). PCTs stated that scientists classify things in a simple and logical way, but that does not mean that it is the only way. The classification should be a way to classify things, but that a universal system must be agreed upon so as not to cause confusion. However, the classification of nature does not always match up.

In scientific decisions sub-aspect, most of the PCTs have an appropriate statement about scientific decisions. They argue that scientist's decision is based on whether the theory has been tested many times and no one has broken it. In technology decisions sub-aspect, most of the PCTs assume that the decision to use or not a technology mainly depends on the impact on the community, if there are too many losses it will not be used (in HM category). The acceptance towards new technologies can be influenced by several factors, including cost, benefits of technology, need for technology, and social influence. However, the decision, whether to use or not new technologies, depends mainly on the personal perspective.

Most of the PCTs have an appropriate statement about the relationship between science, technology, and society. They argue that on the one hand, science and technology affect society but on the other hand, society also influences the development of science and technology.

It is necessary to use the newest technology which utilized the common chemistry concept to make integration of chemistry and technology, such as OLED. The OLED technology is related to concept electroluminescence, molecular orbital theory, etc, which are commonly discussed in the chemistry education program. The analysis of chemistry concept related to OLED comes from several books and articles. The chemistry concept related to OLED technology and integrated into NOST aspects are shown in Table 2.
Table 2. Chemistry concepts related to NOST aspects and OLED.

| Aspects NOST                | Sub-aspects NOST                                      | Concept                          |
|-----------------------------|-------------------------------------------------------|----------------------------------|
| Definition science and technology | 1. Defining science                                      | Organic compound                 |
| Epistemology of science     | 2. Defining technology                                   | OLED structure                   |
| Internal sociology of science | 3. The interdependence of science and technology         | Electroluminescence              |
| Epistemology of science     | 4. Nature of scientific models                          | Molecular orbital theory          |
| External sociology of science| 5. Nature of classification schemes                     | Organic compound in OLED         |
|                             | 6. Scientific decisions                                 | Ionic liquid as electrolyte in OLED|
|                             | 7. Technological decisions                              | Advantages of OLED               |
|                             | 8. The relationship between science, technology, and     | OLED fabrication                 |
|                             | society                                               |                                   |

4. Conclusion
The results show that the PCTs’ VNOST were at inadequate ability. There were many PCTs in HM and N category. Research outcomes are data about student VNOST and chemical concepts related to OLED that can be used as a basis for further research related to how to improve student VNOST through OLED learning. This research will be used as a basis for developing didactical designs for PCTs on OLED learning.

5. References
[1] R.W.Bybee, J.C.Powell, and J.D.Ellis 1991 Integrating the History and Nature of Science and Technology in Science and Social Studies Curriculum *Sci. Educ* 75 143–155
[2] Tairab H H 2001 Res. Sci. Tech. Edu 19 235-250
[3] U.Zoller et al 1990 *Goal Attainment in Science- Technology-Society (S/T/S) Education and Reality: The Case of British Columbia* 74 19–36
[4] OECD 2016 PISA 2015 *Results (volume I) Excellence and Equity in Education* (Paris: OECD Publishing) p 44
[5] Benceze 2011 *NoST Education* Ontario: University of Toronto
[6] Tala, S 2009 Unified view of science and technology for education: Technoscience and technoscience education *Science and Education* 18 275–298
[7] J.O. Matson and S. Parsons 2002 The Nature of Science: Achieving Science Literacy by Doing Science in The Nature of Science Education edited by W.F. McComas Kluwer Academic Press, New York p 223-230
[8] Chamizo J A 2013 Found Chem. 15 157-170
[9] J.Burns 1992 Students Perceptions of Technology and Implications for An Empowering Curriculum *Res. Sci. Educ* 22 72–80
[10] Tsujimura T 2012 *OLED Display Fundamental and Applications* New Jersey: John Wiley and Sons
[11] Blochwitz J M P T F and Leo K 1998 Low Voltage Organic Light Emitting Diodes Featuring Doped Phthalocyanine as Hole Transport Material *Applied Physics Letters* 73 6 729–731
[12] A Jones 1997 Recent Research in Learning Technological Concepts and Processes *Int. J. Technol. Des. Educ* 7 83–96
[13] K Kiliç, S Sungur, J Cakiroğlu, and C Tekkaya 2005 *Ninth Grade Students Understanding of The Nature of Scientific Knowledge* Hacettepe Üniversitesi Eğitim Fakültesi Derg 28 127–133
[14] N.Yenice and G.Saydam 2010 The views of the 8 th grade students about nature of scientific knowledge *Procedia Soc. Behav. Sci* 2 2 5012–5017
[15] M S Koskal and K Sormunen 2014 Advanced Science Students’ Understanding on Nature of Science in Turkey *Asia-Pacific Forum Sci. Learn. Teach* 15 1 1–14
[16] R Sangsa-ard, K Thathong, and S Chapoo 2014 Examining Grade 9 Students’ Conceptions of The Nature of Science Procedia - Soc. Behav. Sci. 116 382–388
[17] S Y Yoon, J K Suh, and P Soonhye 2014 Korean Students’ Perceptions of Scientific Practices and Understanding of Nature of Science Int. J. Sci. Educ. 3 16 2666–2693
[18] H Michel and I Neumann 2016 The Relation Between Students’ Nature of Science Understanding and Their Learning About the Concept of Energy Sci Educ 25 951–975
[19] S Jauhariansyah, A Mudzakir, and T Widhiyanti 2017 Analysis of pre-service chemistry teacher view toward nature of science and technology as a base for integrated technoscience course: fabrication of organic light-emitting diodes International Conference on Mathematics and Science Education p 773-781
[20] H H. Tairab 1999 Pre-service teachers’ views of the nature of science and technology before and after a science teaching methods course Res. Educ. 65 1 81–87
[21] Aikenhead G S, Ryan A G and Fleming R W 1989 Views on Science-Technology Society Saskatoon: Department of Curriculum Studies, University of Saskatchewan p 1-116
[22] Rubba P A and Harkness W L 1993 Examination of preservice and in-service secondary science teachers’ beliefs about science-technology-society interactions Science Education 77 4 407–431
[23] A Vazquez-Alonso and M Manasero-Mas 1999 Response and scoring models for the ‘Views on Science-Technology-Society’ instrument Int. J. Sci. Educ. 21 3
[24] Mitschke U dan Bauerle P 2000 The electroluminescence of organic material J Mater, Chem 10 1471-1507
[25] Gaspar D J and Polikarpov E 2015 OLED Fundamentals Materials, Devices, and Processing of Organic Light-Emitting Diodes Florida Taylor & Francis Group
[26] Banerji A, Tausch M W, and Scherf U 2013 Classroom experiments and teaching materials on OLEDs with semiconducting polymers Educación Química 24 1 17–22

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