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CAN NANPCELLULOSE-TEXT AFFECT THE FIRST-YEAR PRE-SERVICE TEACHERS' CHEMICAL LITERACY?

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Abstract

This research aims to identify the weaknesses of the nanocellulose context based-enrichment book against chemical literacy ability of pre-service teachers based on scientific attitudes and scientific competencies in PISA 2015 through individualized learning. This research uses descriptive method. This research involved 18 first-year students of chemical education. The Instrument that used in this research is multiple-choice questions based on scientific attitudes and scientific competencies in PISA 2015 and linked to nanocellulose and ionic liquids context. The results of this research are the percentages of the weaknesses of chemical literacy ability, the results are as follows: 1) in the attitude aspects of "interest in science and technology", environmental awareness, and valuing scientific approaches to inquiry, the results obtained respectively for 78,0%, 5,6%, and 100,0%; 2) Apply appropriate scientifc knowledge, 11,0%; 3) Identify, use and generate explanatory models and representations, 59,3%; 4) Justify appropriate predictions, 44,4%; 5) Offer explanatory hypotheses, 83,0%; 6) Explain the potential implications of scientifc knowledge for society, 50,0%; 7) Distinguish questions that could be investigated scientifcally, 22,0%; 8) Transform data from one representation to another, 89,0%; 9) Analyse and interpret data and draw appropriate conclusions, 11,1%. Based on the results, the nanocellulose context based-enrichment book has a weakness in developing scientific attitude "environmental awareness" and has weaknesses in developing sub-scientific competencies "apply appropriate scientific knowledge", "distinguish questions that could be investigated scientifically" and "analyse and interpret data and draw appropriate conclusion".

Keywords: nanocellulose-text, PISA 2015, descriptive method

Introduction

Science and technology are two matters that growing all the time. Science and technology are very important in daily life, such as in education, health, agricultural, industrial, and others. An understanding of science and technology is base of a person's preparedness for life in modern society [1]. The need for an understanding of science and technology can be fulfilled by following an education which there is. Manpower Services Commission (1981: 17, which was superceded by the now-defunct Training Commission, U.K.) defined education as an activities which aim at developing the knowledge, skills, moral values and understanding required in all aspects of life rather than knowledge and skill relating to only a limited field of activity [2]. These matters are appropriate with expressed by Sulaiman (2000), that scientific knowledge is taught to produce society that literate in science for interests of individual, social, and society [3].

Scientific literacy is an ability of using scientific knowledge to identify the question and to help to make a decision about phenomena that occur in nature and the changes that occur through human activities [4]. In addition, Bond (1989) states that scientific literacy is an understanding of the scientific facts and the inter-relationships between science, technology and society and the ability to apply them to real-world problems [5]. The concept of scientific literacy in PISA 2015 refers to knowledge of both science and science technology-based, even though the purposes, processes and products of science and technology is different. Technology seeks to the optimal solutions for human problems. in contrast, science seeks to answer to a specific question about the natural and material in the world. Nevertheless, science and technology are closely related. For example, new scientific knowledge leads to the

development of new technologies and new technologies can lead to new scientific knowledge. Individuals make decisions and choice of influence the directions of new technologies [6]. According to PISA 2015, the scientific literate person should be able to makes more informed choices. They should be able to recognize that science and technology are often a source of solutions, they can also be seen as a source of risk, generating new problems that can only be solved through the use of science and technology. Therefore, individuals need to be able to weigh the potential benefits and risks of the applying scientific knowledge to themselves and society [6]. In addition, PISA 2015 states that scientific literacy also requires not just knowledge of the concepts and theories of science but also knowledge of the common procedures and practice associated with scientific enquiry and how these enable science to advance. Therefore, scientifically literate of individuals should have three scientific competencies, they are explaining phenomena scientifically, evaluating and designing scientific enquiry, interpreting data and evidence scientifically. Scientifically literate of individuals should also have three scientific attitude, they are interest in science, valuing scientific approaches to enquiry, and environmental awareness [6]. Chemistry is a part of natural science, so the chemical literacy is relate with scientific literacy. According to Cigdemoglu and Geban (2015), chemical literacy is an ability of using and connecting some information that given in chemical problems and an ability of using chemical knowledges and skills in indicating some informations that relate with daily problems [7]. In addition, Harlen (2001) said that chemical literacy entails an understanding of the chemical components of any publicly discussed issue. Possessing an understanding of the concepts of chemistry, in order to make informed decisions that will affect society, is more important than mastering a body of chemical knowledge [5]. To achieve the goal of educating chemically literate, the chemistry curricula have been change, in keeping with reforms of the other science subject curricula in many countries [5]. To built a chemically literacy ability of Indonesian students, the government of Indonesia applied a 2013 curriculum that became a guidelines for conducting a learning activities. In addition to 2013 curriculum that applied as a guidelines for conducting a learning activities, according to the International Council for Science (ICSU) (2011), one of the factor that affect to chemically literacy ability is education facilities [8]. One of the education facilities is the education book. Education book is the book that used to learn an object of knowledge, science, and technology or a field of study. According to the scope of authority in quality control, education book is divided into two types, i.e. textbook and non-textbook. Non-textbook is the book which used indirectly to learn one of field of study. The enrichment book is one of the non-textbook [9]. Central bookkeeping of the national education department of the Republic of Indonesia (2005), says an enrichment book is a book that can be used by general society also school society, but it is not a primary handbook that used by student in learning activities [10]. An enrichment book is a book that used to support learning processes in any levels of education. According to Central bookkeeping of the national education department of the Republic of Indonesia, the enrichment book has a function as an enrichment of knowledge, to enhance the knowledge and broaden readers about science, technology and art [10].

Technologies in chemistry field that emerging recently are nanocellulose and ionic liquids. Nanotechnology is the understanding and controlling of matter at dimensions of roughly 1-100 nm, and nanomaterials from cellulose play a large role in the nanotechnology field [11]. According to Ioelovich (2012), nanocellulose is the material from cellulose that marked with increased crystallinity, surface area, aspect ratio, dispersion ability, and has the properties of biodegradable. Nanocellulose particles are new class of cellulose materials that can find the wide application in various technical areas, biotechnology and medicine [12]. Nanocellulose has became increasingly popular for the past decade because of its unique properties such as low density, high tensile strength, high Young's modulus, modifiable surface properties, biodegradability, biocompatible as well as great availability from renewable resource [13].

Ionic liquid is a salt R[X] with a melting point below 100^0C. It would be tempting to define them as those that are liquids at room temperature. Most commonly, an ionic liquid consist of an organic cation $[R]^+$ and an inorganic anion X^- [14]. Ionic liquids are known as "green solvents", because the ionic liquids have some amazing characteristics such as having a low vapor pressure, thermal and chemical stability, non-flammable, low viscosity, and can be recycled [13]. One of the functions of ionic liquids is to isolate the nanocellulose from

cellulose. Ionic liquids are capable of dissolving cellulosic biomass [13].

As part of the society as well as prospective educators, pre-service chemistry teachers should have the chemically literacy ability such as having scientific attitudes and scientific competencies that has been formulated by PISA 2015 as a form of readiness to apply their knowledge to the development of the technology and also as an expression of readiness to educate students to have the chemical literacy ability. The use of the context based enrichment book of nanocellulose is expected can be to build the chemical literacy ability of the pre-service chemistry teachers. However, this book has not been tested can build the chemical literacy ability of the pre-service chemistry teachers. Based on the description above, the purpose of this research are as follows:

1) to identify the weaknesses of the context based enrichment book of nanocellulose to built the scientific attitudes of pre-service chemistry teachers.
2) to identify the weaknesses of the context based enrichment book of nanocellulose to built the scientific competencies of pre-service chemistry teachers.

Experiment

Research Method and Research Object. This research uses descriptive method with the aims to describe the phenomena that exist in what are [15]. The object of this research is context based enrichment book of nanocellulose. This research aimed to describe the weakness of the context based enrichment book of nanocellulose in developing a scientific attitude and scientific competence in PISA 2015 with first-year students of chemistry education department as participants. Context based enrichment book of nanocellulose that used is technology-based knowledge enrichment book in which to discuss about the nanocellulose and ionic liquids context associated with chemistry content that studied in senior high school. The book has 35 pages with A5 paper size.

Participants. The numbers of participants in this research were 18 students of the first-year students of chemistry education department, Indonesia university of education. Of the 18 participants, 5 of who were men, while 13 were women.

Instrument. The instrument that used in this study is a multiple choice test items to test aspects of the scientific attitude and scientific competence in PISA 2015 were linked to the nanocellulose and ionic liquids context. However, not all scientific sub competencies used in the preparation of the multiple-choice test items. Scientific sub competence that used are "Apply appropriate scientifc knowledge", "Identify, use and generate explanatory models and representations", "Justify appropriate predictions", "Offer explanatory hypotheses", "Explain the potential implications of scientifc knowledge for society", "Distinguish questions that could be investigated scientifically", "Transform data from one representation to another", and "Analyse and interpret data and draw appropriate conclusions". The instrument consisted of 14 test items, 3 of 14 test items are based on three aspects of the scientific attitude "Interest in science", "Valuing scientific approaches to the inquiry", and "Environmental awareness", whereas 11 test items prepared on scientific sub competencies that selected before.

Collecting and Processing Data. At first, participants read a context based-enrichment book of nanocellulose for 45 minutes. After all participants read the book, the participants answered test items that have been created based on the scientific attitudes and scientific sub competencies that determined before.

Weakness analysis of enrichment text is done by calculating the correct answers given by participants per indicator, then dividing the number of correct answers by the number of overall response per indicator, then multiplied by 100%, based on the following formula:

$$K = \frac{Jb}{s}$$

with:

K = comprehension

Jb = Number of participants answered with correct answer

s = total of answers

From the scores that obtained, carried out the weaknesses of enrichment text categorization based text comprehension categories by Rankin and Culhane [16]. Text with percentage of comprehension in the range 61 to 100% ($61 < K \leq 100\%$) is categorized as independent category. It means that the use of enrichment book can be done individually by someone without the help of a teacher/instructor. Text with percentage of comprehension in the range 41 to 61% ($41 < K \leq 61\%$) is categorized as instructional category. It

means that the use of enrichment books still need the guidance of a teacher / instructor. Text with percentage of comprehension under 41% (K ≤ 41%) is categorized as frustrating category. It means that an enrichment books that failed and can not be used by someone.

Result and Discussion

Weakness of context based enrichment book of nanocellulose on the scientific attitude aspects

From Figure 1, it appears that 5.6% of participants responded with the correct answer on the test item with a scientific attitude indicator "environmental awareness". Text in enrichment book associated with “enviromental awareness" has the comprehension criteria on frustrating category; it indicates that the text in enrichment book is not able to develop an attitude of environmental awareness among participants. In the enrichment book, there is a discourse that discusses about ionic liquids that are environmentally friendly, but participants can't apply it in the given cases on test items. Enrichment book must have one of the eligibility requirements, i.e. to encourage the reader to experience and discover for you the positive things that can be applied in everyday life [17].

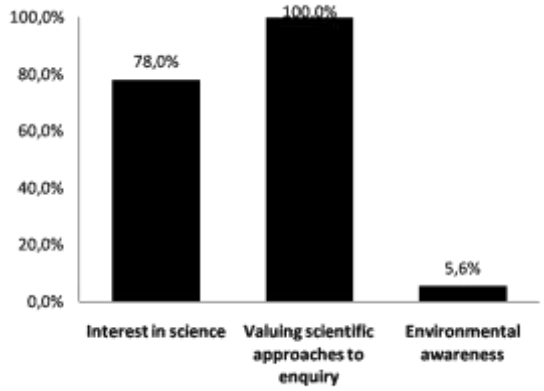

Figure 1 Graph of the percentage of correct answers on test items with PISA 2015 scientific attitude indicators

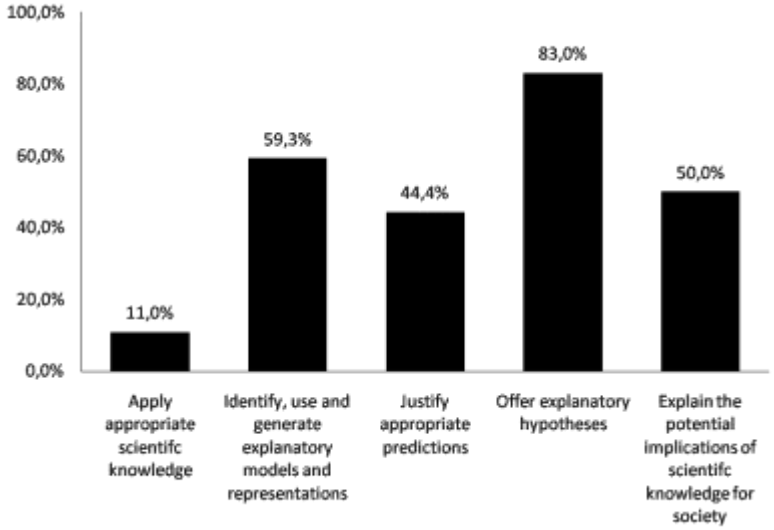

Figure 2. Graph of the percentage of correct answers on a test subject with scientific competence indicator "explain phenomena scientifically"

Weakness of context based enrichment book of nanocellulose on scientific competence in PISA 2015

From Figure 2, 11.0% of participants responded with the correct answer on a test item with scientific sub competence indicator "Appropriate apply scientific knowledge".

Demonstrate competence "explain phenomena scientifically" requires one to remember and apply knowledge appropriate to the given situation. The person who literate in science is expected to describe the standard scientific model to build a simple representation to explain everyday phenomena [6]. The text in enrichment book that associated with the sub competence "Appropriate apply scientific knowledge" has a comprehension criteria on frustrating category, it indicates that the text in enrichment book have not been able to develop the sub competency "Appropriate apply scientific knowledge" on participants. On the text in enrichment book, there is a discourse that discusses about cellulose belonging to the polysaccharides, but participants can not apply it in the given cases on the test item.

From Figure 3, 22.0% of participants responded with the correct answer on the test item with scientific sub competency indicator "distinguish questions that could be investigated scientifically". The person who literate in science must have the ability to distinguish scientific inquiry from other forms of investigation or identify the questions that can be investigated scientifically in certain contexts [6]. The text in enrichment book that related with sub competency "distinguish questions that could be investigated scientifically" have a comprehension criteria on frustrating category, it indicates that the text in enrichment book have not been able to develop a sub competency "distinguish questions that could be investigated scientifically" on participants. In the text in enrichment book, there is a discourse that discusses about nanocellulose which has hydrophilic properties and can form colloidal properties, but the participants have not been able to apply it in determining the question that can be investigated scientifically in the test item.

From Figure 4, 11.1% of participants responded with correct answer on the test item with scientific sub competency indicator "analyse and interpret data and draw appropriate conclusions". The person who literate in science should be able to interpret and understand the basic forms of scientific data and evidence used to make a claim and draw conclusions [6]. The text in enrichment book that related with sub competency "analyse and interpret data and draw appropriate conclusions" have a comprehension criteria at frustrating category, it indicates that the text in enrichment book have not been able to develop the sub competency "analyze and interpret data and draw appropriate conclusions" on participants. On the text in enrichment book, there is a discourse that discusses about ionic liquids that have a melting point at room temperature or below 100^0C, but participants can not apply it in the given case in the test item. The enrichment book must have one of the eligibility requirements of enrichment books, i.e. the contents in the book should be able to support the achievement of educational goals [17]. In this case, the context based enrichment book of nanocellulose must be able to support the achievement of scientific competence in PISA 2015.

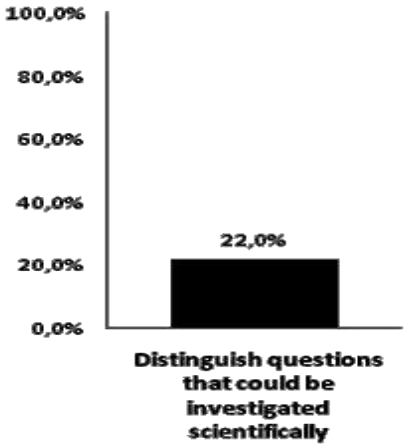

Figure 3. Graph of the percentage of correct answers on a test subject with scientific competence indicator "evaluate and design scientific enquiry"

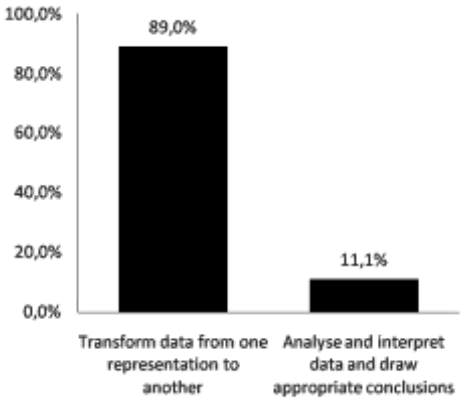

Figure 4. Graph of the percentage of correct answers on a test subject with scientific competence indicator "interpret data and evidence scientifically"

Conclusion

Based on the results, the enrichment book of nanocellulose context-based has a weakness in developing scientific attitude "environmental awareness" and has weaknesses in developing sub-scientific competencies "apply appropriate scientific knowledge", "distinguish questions that could be investigated scientifically" and "analyse and interpret data and draw appropriate conclusions".

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