Pre-service primary school teachers’ abilities in explaining water and air pollution scientifically

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Abstract. The purpose of this study is to determine the ability of pre-service primary school teachers (PSPST) in explaining the phenomenon of water and air pollution scientifically. The research method used descriptive method of analysis with qualitative approach. The respondents were PSPST at 4th semester. This study used a four-tier instrument diagnostic test. The number of subjects was 84 PSPST at Universitas Pendidikan Indonesia, Kampus Daerah Sumedang. The results demonstrate the ability of PSPST in explaining water and air pollution scientifically. The results show that only 6% of PSPST who are able to explain the phenomenon of water pollution and only 4% of PSPST who are able to explain the phenomenon of air pollution. The fact should be attention for PSPST because these understanding are crucial in the process of learning activities in the classroom.

1. Introduction
Teacher is a professional staff in charge of planning, implementing, guiding and assessing educational outcomes. Therefore, the role of teacher as professionals is an educator, teacher, tutor, trainer, program developer, and program manager. Student Teacher Education Program as an institution that educates pre-service teacher, need to equip them with the competencies as a learning agent. It is written at Law No.14 of 2005 on teachers and lecturers and based on government regulation No. 19 of 2005 on national education standards.

One of the important capabilities to develop is the ability of PSPST in explaining scientifically primary school. Mastery in explaining scientifically will allow the students have a good understanding of the problems described, as well as increased involvement of students in learning activities. Moreover, the interaction between teachers and students allowing them to create meaningful relationships between learning and their daily life outside of classroom [1]. Explaining scientifically is student mastery in understanding, analyzing, and interpreting according to a scientific concept. The role of teachers in explaining scientifically will shape the scientific view, logical thinking, as well as cultural activities to finding information in self-students [2]. This mastery is needed by primary school teachers. Mastery of the correct concept then in the process of learning at school will be well received by students and avoid misconception. Similar to the statement [3], the misconception refers to an inaccurate understanding of a concept, the use of the wrong concept, classification examples wrong
about the application of the concept, the meaning of different concepts, and or the chaos of different concepts.

The nature of science includes four main elements: 1) an attitude: curiosity about objects, natural phenomena, living beings, as well as the causal relationship may create new problems that can be solved through correct procedures; 2) process: the troubleshooting procedure through scientific methods. The scientific method includes the preparation of the hypotheses, designing experiments or trials, evaluation, measurement, and conclusions; 3) product: the form of facts, principles, theories, and laws; 4) application: the application of scientific methods and concepts of science in daily life [4]. The purpose of science is to construct an explanation of the causes of the phenomenon [5]. From these explanations, the process of science implies how or scientific activity to describe natural phenomena that science product obtained in the form of facts, principles, laws, or theories.

According to the results of the Program for International Student Assessment (PISA) in 2015 which was released on December 6, 2016, shows the Indonesian education system is still very low. Indonesia was 64th from 72 countries such as Brazil, Peru, Lebanon, Tunisia, Macedonian, Kosovo, Algeria, and Dominica. The best five of PISA 2015 were Singapore, Japan, Estonia, Taiwan, and Finland [6]. PISA 2015 defines scientific literacy is the ability to explain scientific phenomena, designing and evaluating scientific research, as well as interpreting data and scientific evidence. There are three dimensions of competence assessment in the PISA science literacy process. They are explaining scientific phenomenon that is applied on scientific knowledge in a given situation, describing or interpreting phenomena and predicting changes, identifying descriptions, explanations, and predictions accordingly [7].

Before entering primary school and science taught formally, students usually bring the basic idea of science is based on the natural phenomena they see in everyday life. They already have the knowledge of what would happen if they draw, beat, and dropping an object. In fact, they also have a basic knowledge about the world and its natural surroundings, such as water, light, fire and shadow [8]. Research shows that students from different countries with a variety of different cultures appeared to have similarities in view of scientific concepts. The concept of science is not associated with the local culture but shaped by personal experiences of the students themselves when in contact with natural phenomena [5]. Although it is said that the concepts of science in students is a personal experience, there is no doubt that the process of interaction with friends, teachers, and the education system have also influenced the conception of science on students. When students enter the world of school, their science knowledge intersects with the status of science as a public knowledge.

Based on the above explanation, it will be a challenge for primary school teachers to teach science in schools to give access to the students to construct scientific concepts on students, as well as introducing the concepts of truth that has been agreed by the scientific community. Therefore, prospective students need to develop the skills of primary school teachers in understanding, analyzing, and interpreting phenomena scientifically in accordance with the concept of true science. So expect student primary teachers are able to teach science lessons to students well later when they are ready to become an primary school teacher professionalism.

Regulation of Ministry of National Education No.16 of 2006 on Academic Qualification Standards and Competencies Teacher, professional competence to master the material, structure, concept and mindset of scientific support science subjects include: (1) is able to make observations of natural phenomena either directly or indirectly; (2) utilizing the concepts and laws of science in various situations of everyday life; (3) understand the structure of natural science, including functional relationships between concepts, which is associated with natural science subjects [9].

Water and air pollution by Law No. 23 of 1997 on environmental management and PP RI No. 82 of 2001 on water quality management and water pollution control defines water pollution is the entry or the inclusion of living creatures, substances, energy, and or other components to in water by human activities, so that the water quality drops to a certain level which causes the water cannot function as intended [10]. Meanwhile, air pollution is the event of the entry, or a mixture of pollutants (hazardous elements) into a layer of air (atmosphere) which may result in the reduction of air [11]. Based on the
description that has been put forward, the purpose of this study is to determine the ability of PSPST in explaining scientifically about air and air pollution.

One contained lesson science in primary schools is the problem of environmental pollution. Environmental concept itself is conceived of human interaction with the natural environment [12]. Pollution of the environment is a concept that is very complex, because it contains a variety of scientific fields such linkages, chemistry, physics, and biology. So is the concept of water and air pollution that are part of environmental pollution require teachers and even students understand the concept well in order to avoid wrong conception. Based on the description that has been said, the researchers will conduct a study entitled "Analysis of Prospective Students Ability Primary School Teachers Explaining about the Scientific Phenomena in Water and Air Pollution".

2. Methods
The use of the method in research is a necessary condition to obtain the depth of the problem, and also be able to collect all the necessary information and data with regard to the issue. In this case study method is a concrete step to answer the questions that arise in the study. The research method is a tool to get the results of the study conclusions.

The method used in this study used a qualitative approach with descriptive method of analysis. The position of this method is to help solve the problems to be studied. Descriptive research is a form of research that indicated to describe phenomena that exist, whether a natural phenomenon or man-made phenomenon. The phenomenon can be a form of activity, characteristics, changes, relationships, similarities, and differences between the phenomena with each other phenomena [13]. In this study may be explained that the descriptive method of analysis is how to solve a problem or phenomenon by analyzing and interpreting the data exist based on accurate facts.

This research was undertaken in study Primary School Teachers Education program of Universitas Pendidikan Indonesia. The subject of this research is actives student of Primary School Teachers Education study program at semester 4th. Appropriate with the purpose of college is to produce graduates of professional education personnel, especially primary school teachers, so it will be appropriate if the subject of the study was conducted on campus.

The instrument used in this study a matter tests and questionnaires. Problem test using a 4-tier format diagnostic test, while the questionnaire is used to amplify the data obtained from the test item. 4-tier diagnostic test capable of measuring the level of students’ knowledge and explanation content [14]. The research instrument in the format of a 4-tier diagnostic test available that is able to explain the category of scientific phenomena, unable to explain the phenomenon scientifically, and have misconceptions [15]. Of these categories, then be analyzed by each tier (predict, explain, images, and the level of confidence) descriptively. While the questionnaire used in a variety of settings to gather information about the opinions and behaviors of individuals [16].

| Level analysis | Category (Diagnosis) | Answer Type                                                                 |
|----------------|----------------------|----------------------------------------------------------------------------|
| Four tier test | Being able to explain scientifically | Correct answer + correct reason + correct symbol or picture + sure |
|                | Not being able to explain scientifically | Incorrect answer + correct reason + correct symbol or picture + not sure |
|                |                      | Correct answer + incorrect reason + correct symbol or picture + not sure |
3. Results and Discussion

Research conducted at Universitas Pendidikan Indonesia, Kampus Daerah Sumedang data obtained were 84 primary student teachers in semester 2. The data consists of test questions the ability to explain the 4-tiered format diagnostic tests and questionnaires. Tests amounted to a question about the phenomenon of water pollution and the problem of the air pollution phenomenon. The questionnaire consisted of 12 questions aimed at identifying the capabilities of the primary student teachers with the ability to explain the phenomenon of water and water pollution scientifically.

Based on the test results the ability to explain the phenomenon of water and air pollution scientifically can be observed in Table 2.

| Question | Category | Amount | Percentage |
|----------|----------|--------|------------|
| The phenomenon of water pollution | Being able to explain scientifically | 5 | 6% |
| | Not being able to explain scientifically | 43 | 51% |
| | Misconceptions | 36 | 43% |
| The phenomenon of air pollution | Being able to explain scientifically | 3 | 4% |
| | Not being able to explain scientifically | 46 | 55% |
| | Misconceptions | 35 | 41% |

PSPST are able to explain the phenomenon of water pollution just as much as 5 meaning that only 6% of it and worrying phenomenon of air pollution over again just 3 means 4%. Students who are not able to explain the phenomenon of water pollution as much as 43 or 51% and the phenomenon of air pollution as much as 46 or 55%. Then student misconceptions in explaining the phenomenon of water pollution as much as 36 or 43% and the phenomenon of air pollution as much as 35 or 41%.

From every aspect of the question of water pollution phenomenon suggests that the majority of PSPST know, experience, even understand the phenomenon of water pollution. As many as 83% of PSPST answered prediction of a phenomenon correctly, only 17% have answered "do not occur and did not know about this phenomenon". But of the many who answered correctly from such
predictions, is not significant to their ability to explain and justify the phenomenon of water pollution. Only about 6% of students from primary teacher candidates who answered correctly. They were able to answer correctly, also capable of properly representing the annotations in an image with a level of confidence that is confident with their answers.

Not much different from the phenomenon of water pollution, in every aspect of the question of air pollution phenomenon also shows that school student teachers know and understand about the phenomenon, evidenced from the results predicted they answer correctly the phenomenon of air pollution. Some 77% of students prospective primary teachers answered correctly and 23% answered incorrectly and do not know. While their ability to provide an explanation or excuse of an air pollution phenomenon only 5 people who answer correctly. This is highly insignificant from the ability to predict the phenomenon by providing an explanation of the phenomenon. Those who answered correctly were able representation their explanations with an image well. Unfortunately, 5 people who were able to explain the phenomenon of air pollution among them has a different level of confidence. A total of three people answered confidently and 2 answered hesitantly. From the level of confidence it can be concluded that only three of the people who have the ability to explain scientifically the phenomenon of air pollution when using measurement instrument 4-tier diagnostic test. Only 4% of PSPST who have the ability to explain the phenomenon of air pollution. From the level of confidence it can be concluded that only three of the people who have the ability to explain scientifically the phenomenon of air pollution when using measurement instrument 4-tier diagnostic test. Only 4% of PSPST who have the ability to explain the phenomenon of air pollution. From the level of confidence it can be concluded that only three of the people who have the ability to explain scientifically the phenomenon of air pollution when using measurement instrument 4-tier diagnostic test. Only 4% of PSPST who have the ability to explain the phenomenon of air pollution.

Data obtained also show that the dominant PSPST gained knowledge about the phenomenon of air and water pollution from television and internet. The complete information as follows.

![Figure 1. Knowledge about the phenomenon of air pollution](image_url)
Books and newspapers as a source of information on air and water pollution for PSPST is still very low. This shows the low PSPST science literacy. Reading habits become another matter so that information obtained from other sources may not necessarily support understanding their concepts.

One example of a misunderstanding in answering the phenomenon of pollution, such as answering pollutants spread because air carried by the wind. They do not respond with the concept of heat transfer. So it can be concluded that they did know a phenomenon but without being supported with the correct concept.

Misconceptions in explaining scientific phenomena on water and air pollution occurs because primary student teachers still do not understand the concept of heat transfer by convection. The concept of the convection phenomenon is closely related to water and air pollution. Of the many answers to student teachers very sidetracked primary and far from explaining the concept of convection. Misconception occurs because prior knowledge of the individual that is obtained either from the surrounding environment, books, even teachers. It is also supported by the findings of the questionnaires showed that as many as 65% of primary school student teachers stated that the material about water and air pollution is a subject matter which is considered difficult.

Last educational background of students who mostly focus on the concentration of social education, not science education be another reason why the ability to explain the scientific basis of the phenomenon of low water and air pollution. Whereas the basic science concepts they have learned in the previous semester. It is very unfortunate when the ability to explain scientific phenomena PSPST is low, because it is basically an primary school teacher needs to master all areas of material, be it science, social studies, mathematics, or other subjects that are taught in primary school.

Therefore, it is of concern that it turns out the majority of PSPST still not able to explain the phenomenon of air and water pollution and almost half of those misconceptions to explain the phenomenon. This statement is backed by the results of tests the ability to explain scientific phenomena are still a lot of misunderstanding in giving reasons for the phenomenon.

The results of this study are significant from previous studies, that’s still a lot going on elementary school teachers that still has a low understanding and have a misunderstanding of the concept of science. Mastery of the concepts of this low will have an impact on the development of teachers in implementing learning [17]. One of them there is the capability of explaining phenomena.
scientifically. This inability will fatal if teachers did not attempt to master the concept. Result in their learning to students who will join the wrong concept as well.

4. Conclusion
The ability to explain scientific phenomena which is mastery in understanding, analyzing, and interpreting according to a scientific concept. Important capabilities that should be developed by teachers and PSPST as one of the competencies required of a professional teacher. This capability is required of primary school teachers as the provision of teaching for the true mastery of the concepts in the learning process in schools will be accepted by both the students and avoid misconceptions. Based on research Universitas Pendidikan Indonesia, Kampus Daerah Sumedang concludes that PSPST in the ability to explain the phenomenon of water and air pollution scientifically still very low. The dominant source of information they get about the phenomenon of water and air pollution is obtained from television and internet. The low ability to explaining the phenomenon of water and air pollution because low understanding of concepts related to the phenomenon, educational background, and lessons about pollution as one of the lessons that are considered difficult. In addition, less curiosity and less critical thinking about the surrounding environment is another reason for the low ability to explaining scientifically in the PSPST.

5. References
[1] Hynds A S, Hindle R, Savage C, Meyer L H, Penetito W and Sleeter C 2016 The impact of teacher professional development to reposition pedagogy for Indigenous students in mainstream schools The Teacher Educator 51 3 230-249
[2] Gilmanshina S I, Gilmanshin I R, Sagitova R N and Galeeva A I 2016 The Feature of Scientific Explanation in the Teaching of Chemistry in the Environment of New Information of School Students' Developmental Education International Journal of Environmental and Science Education 11 4 349-358
[3] Crowther G J and Price R M 2014 Re: Misconceptions are “so yesterday!” CBE-Life Sciences Education 13 1 3-5
[4] Djojosoediro W 2010 Pengembangan Pembelajaran IPA SD (Bandung: Universitas Pendidikan Indonesia)
[5] Driver R and Leach J 1993 A constructivist view of learning: Children’s conceptions and the nature of science What Research Says to Science Teacher 7 103-112
[6] Deiters R M 1968 Organization for Economic Co-Operation and Development (OECD)
[7] Bybee R and McCrae B 2011 Scientific literacy and student attitudes: Perspectives from PISA 2006 science International Journal of Science Education 33 1 7-26
[8] Sulistyowati E and Wisudawati A W 2015 Metodologi Pembelajaran IPA (Jakarta: Bumi Aksara)
[9] Peraturan Menteri Pendidikan Nasional 2006 Standar Kualifikasi Akademik dan Kompetensi Guru (Jakarta: Permendinas)
[10] Kementerian Lingkungan Hidup 1997 Undang-Undang No.23 tahun 1997 tentang Pengelolaan Lingkungan Hidup (Jakarta: Kementerian Lingkungan Hidup Republik Indonesia)
[11] Kementerian Lingkungan Hidup 1997 Peraturan Pemerintah No.82 tahun 2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran air (Jakarta: Kementerian Lingkungan Hidup Republik Indonesia)
[12] Heck E H 2015 Environmental Education in Vietnam: A Case Study at Le Loi Elementary School
[13] Sukmadinata S 2006 Metode Penelitian Pendidikan (Jakarta: Bumi Aksara)
[14] Caleon I S and Subramaniam R. 2010 Do students know what they know and what they don’t know? Using a four-tier diagnostic test to assess the nature of students’ alternative conceptions Research in Science Education 40 3 313-337
[15] Gurel D K, Eryilmaz A and McDermott L C 2015 A Review and Comparison of Diagnostic
Instruments to Identify Students’ Misconceptions in Science. *Eurasia Journal of Mathematics, Science & Technology Education* **11**

[16] Williams A 2003 How to… Write and analyse a questionnaire. *Journal of orthodontics* **30** 245-252

[17] Subramaniam K and Esprivalo Harrell P 2013 Framing prospective elementary teachers’ conceptions of dissolving as a ladder of explanations. *Journal of Science Teacher Education* **24** 7 1177-1199