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# Preface

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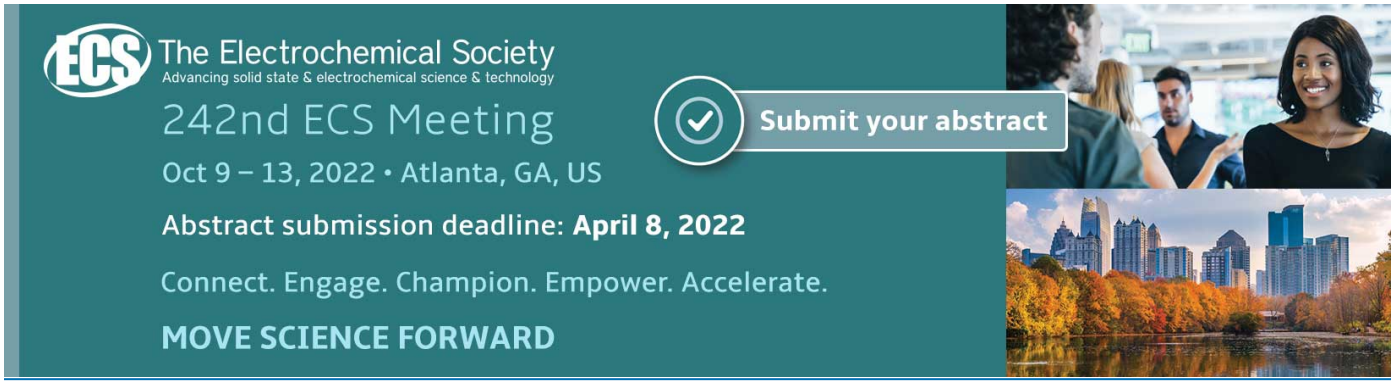

# The Second International Conference on Environmental Geography and Geography Education (ICEGE) 2019

**Sumardi**
Editor in Chief of International Conference on Environmental Geography and Geography Education 2019

E-mail: sumardi.fkip@unej.ac.id

We would like to express our gratitude to all participant who were joining "The Second International Conference on Environmental Geography and Geography Education" (ICEGE). It is the 2nd International conference held by the Department of Social Science Education held by FKIP-University of Jember on 28-29 September 2019. This conference becomes a dissemination forum for scientists who are working on theoretical and empirical research of environmental geography, transportation geography, geography education, social science and its application. The mission of this conference is to become an annual internationalforum in the future, where civil society organization and representative research students, academics and researchers, scholars, scientists, teachers andpractitioners from all over the world could meet and exchange an idea toshare and discuss about research. The aim of the second conference is to present and discuss the latest research that contributes to the new ontological,epestimological and axiological knowledge and to a better understanding in the area as follows:(1) Environmental Geography; (2) Geography Information System and Remote Sensing; (3) Geomorphology; (4) Natural Disaster;(5) Economics; (6) History; (7) Education; (8) Humanities; (9) Social Sciences and (10) Global Science and Studies.
The participants of this ICEGE 2019 were 310 participants consisting research students, academics and researchers, scholars, scientist, teachers and practitioners from many countries. The selected papers to be published on IOP Conference Series: Earth and Environmental Science are 151 papers.

On behalf of the organizing committee, finally we gratefully acknowledge the support from the FKIP-University of Jember of this conference. We would also like to extend our thanks to all lovely participants who have been joining this unforgettable and valuable event.

Assoc. Prof. Sumardi, M.Hum

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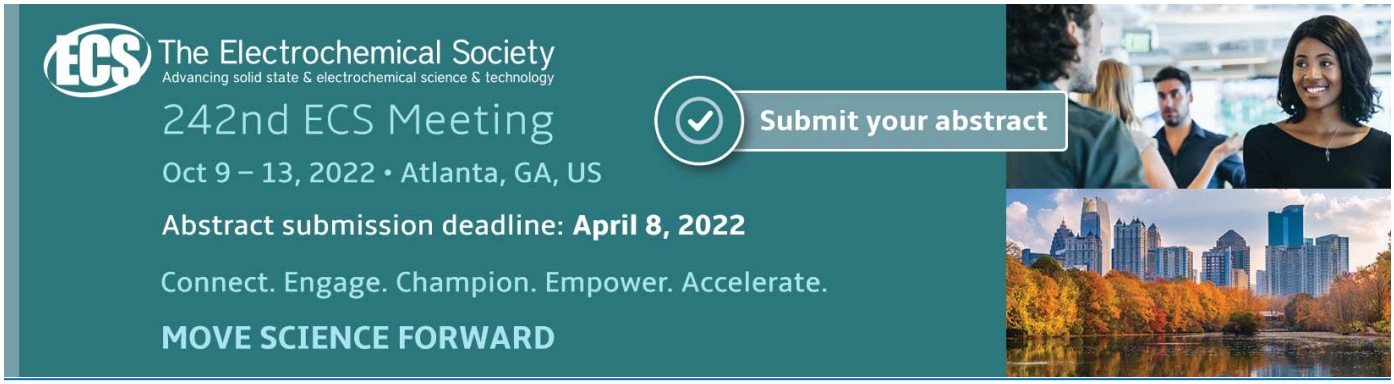

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The committees of the Second International Conference on Environmental Geography and Geography Education would like to express gratitude to all Committees for the volunteering support and contribution in the editing and reviewing process.

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# Pre-service science teachers' understanding of scientific method for studying local environmental issues

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**Abstract.** The scientific method is a procedure used by scientists to test generalizations and hypotheses with observation and experiment activities to obtain proven theories. Scientific methods become an essential part of the development of science, so that science learning teaches them, including in learning about earth science because most of the information in earth science is found through scientific inquiry. Pre-service science teachers must understand the scientific method and its application in studying the local environment so that it can be implemented in the learning process, especially when prospective teacher students carry out teaching practices in schools. Knowledge of the scientific method has many benefits, but not much information about the ability of prospective science teachers to the scientific method and its use to study the local environment. The purpose of this research is to find out precisely the knowledge of prospective science teachers about the scientific method and determine the right strategy in designing content and conducting lectures that teach material about the earth. The study was conducted on 83 prospective science teachers when they attended lectures on earth science. Data is obtained through written test activities that ask about understanding, procedures, and examples of the application of scientific methods in studying local environmental phenomena. The results of the study show that most prospective science teachers have an adequate understanding of the meaning and procedures of the scientific method. However, most students still cannot provide explicit examples of the operationalization of the scientific method in studying local environmental problems. For this reason, it is necessary to apply the right learning strategy so that students have the ability of the scientific method, one of which is to involve students in conducting scientific processes both in the laboratory and in real objects outside the classroom.

## 1. Introduction

Science is always based on the assumption that phenomena in the universe are always consistent, orderly, and predictable. Based on these assumptions, scientists develop knowledge about nature by involving a specific procedure commonly called the scientific method. The scientific method is a systematic procedure for studying phenomena in science. The scientific method is an essential aspect of the nature of science [3] and [14]. Scientists conduct investigations by observing, formulating hypotheses, conducting experiments, analyzing data, and drawing conclusions to build knowledge or theory that is general [17] ;[18]. Furthermore, that knowledge can be used to make predictions and explanations about the phenomena of the universe. Besides being widely used in science, scientific methods can also be applied in constructing knowledge and solving problems about earth science [12]. For example, geologists can explain subsurface rock formations for exploration. To determine the feasibility of exploration, geologists collect scientific data through observations and measurements. Based on the results of the analysis and interpretation of the data, it can be determined whether the subsurface rock formations have potential economic value for exploration.

A scientific method is a conceptual approach that underlies most modern scientific investigations [15]. This method has several procedures that are widely used by scientists to construct knowledge. Scientific investigations always involve systematic stages, including (1) observing phenomena that occur in the natural environment; (2) asking questions based on observing natural phenomena; (3) make observations and measurements to get data about natural phenomena; (4) process and analyze measurement data; (5) answering questions based on the results of data analysis; (6) communicating the results to the audience to get criticism, suggestions, and more testing. The six stages form a

process commonly referred to as a scientific process. The activity begins with observing a phenomenon that leads to the emergence of various questions. Scientists ask additional questions and conduct investigations to obtain data. Data that has been obtained is then analyzed, interpreted, and drawn conclusions [2]. A valid conclusion can only be obtained through a complete and adequate procedure for gaining knowledge.

Science learning in schools must teach, not only focus on science content but also must teach how knowledge is built through scientific methods, so students know knowledge about science is developed [12]. Learning science is primarily learning by involving three main elements; attitudes, processes, and products [7]. Attitude is a form of curiosity about nature that is thoroughly investigated, honest, skeptical, open to new things, and responsible. The process is a procedure of investigation of natural phenomena. Science products in the form of facts, concepts, principles, laws, and theories can explain and predict natural phenomena.

Teaching science must foster students' competencies in aspects of attitudes, knowledge, and skills that can be obtained through a scientific approach. For this reason, an understanding of the scientific method is an essential component in learning about science. Students who have an understanding of the scientific method significantly have predictive abilities for problem-solving strategies [9]. Students who have excellent scientific process skills will have scientific knowledge, scientific reasoning, and critical thinking in developing scientific knowledge [8].

Permendikbud No. 24 of 2016 concerning the standard content of natural science subjects states that one of the essential competencies in science subjects in junior high schools is to explain the layers of the earth, volcanoes, earthquakes, and risk reduction actions before, during and after a disaster. The material covered in these essential competencies includes concepts of the earth's layer, atmosphere, lithosphere, earthquakes, and disaster risk reduction, volcanoes and disaster risk reduction, hydrosphere disaster risk reduction. Based on curriculum demands, the achievement of competencies for these subject matter must involve different psychological processes. Attitude competencies can be obtained through the activities of receiving, running, appreciating, living, and practicing. Knowledge competence is obtained through the activities of remembering, understanding, applying, analyzing, and evaluating. Skill competency is obtained through observing, asking, trying, reasoning, presenting, and creating activities. The approach used to study science is called a scientific approach in which often must involve skills in implementing scientific methods.

Although learning science in schools requires the involvement of scientific methods, most objects of study on earth are in the surrounding environment, so the process requires a long time and is difficult to connect between aspects [13]. This condition causes the learning process rarely involves experimental activities in the laboratory. These limitations can cause students to lack the ability and skills of the scientific method. Schlueter & d'costa [16] states that learning that rarely involves scientific methods in the laboratory causes students to be less skilled in designing experiments, and they do not understand the importance of experimental variables. In the preparation of prospective science teachers, these conditions can also result in the lack of knowledge of prospective teachers of the scientific method. This research conducted to find out precisely the knowledge of prospective science teachers about the scientific method. By knowing the ability of prospective science teachers about the scientific method, it can be determined the right strategy in designing content and conducting lectures that teach material about the earth.

## 2. Methods

This type of research is descriptive research. Descriptive research is research used to describe the problem of a phenomenon that occurs. The purpose of this study is to identify the ability of prospective science teachers in describing the scientific process associated with earth phenomena that exist in the surrounding environment.

Respondents in this study were prospective science teachers who had attended lectures on earth science. The research respondents were 3rd-semester students. The number of respondents was 83 students, 77 students were female, and 6 were male students.

The study was conducted in several stages with the following details.

1. Design a test that asks about the scientific process of the earth's environment phenomenon.
2. Provide test packages to respondents.
3. Respondents answered questions by analyzing knowledge about the surrounding environmental phenomena that can be constructed through the scientific process.
4. Researchers assess and identify the ability of respondents to use science processes in constructing knowledge about environmental phenomena.
5. Interviewing some students who get high, low, and average test scores to confirm the results of the test.
6. Identifying the ability of prospective science teacher students to the scientific process to construct knowledge of the earth environment phenomena.
7. Describe the ability of prospective science teacher students and make conclusions based on test and interview results.

Data collection is done through tests and interviews. The essay test is used to determine the ability of prospective science teacher students to explain the scientific process to construct knowledge about environmental phenomena. The answer to the test requires the respondent to explain the six stages of the scientific process related to the knowledge of the earth. Scoring the test results is based on the scoring rubric. The interview in this study aims to confirm the answers given by respondents during the written test. Interviews were conducted after the researchers assessed the test results. Furthermore, the researchers chose six respondents to be interviewed based on the results of the test with the criteria of 2 respondents who scored high, two respondents with average scores, and two respondents with low scores.

Furthermore, the results of assessments and interviews are used to determine the category of the ability level of prospective science teacher students to the science process related to earth knowledge. Thus the conclusions can be formulated from the data that has been obtained.

## 3. Results and Discussion

The science process proposed by prospective science teacher students on the phenomenon of earth about the surrounding environment can be classified into several groups, as shown in Table 1. Based on the data it appears that there are 8 classifications of the surrounding environment that are objects in the formulation of the scientific process; hazard, layer of earth, tsunami in Honshu, the effect of sunlight on plants, the formation of Lake Toba, the formation of a volcano, suitability of soil to plant type, and others.

**Table 1.** The topic of the scientific process proposed by prospective science teachers.

| The topic of Scientific Method | Number of Students | True Answers |
|---|---|---|
| Hazard | 18 | 3 |
| Layer of Earth | 16 | 4 |
| Tsunami in Honshu | 15 | 10 |
| The Effect of Sunlight on Plants | 8 | 4 |
| The Formation of Lake Toba | 6 | 1 |
| The Formation of a Volcano | 5 | 1 |
| Suitability of Soil to Plant Type | 4 | 2 |
| Others | 11 | 1 |
| **Total** | **78** | **26** |

Based on these data, it can be said that phenomena close to the surrounding environment dominate the earth phenomena selected and used as topics in describing scientific methods. Environmental phenomena that are chosen are about disaster, the impact of sunlight, the formation of Lake Toba, and agricultural land. One phenomenon which happened far away and was chosen by many students was about the tsunami disaster in Honshu Japan in 1700. Some other phenomena are

not directly related to the phenomenon of the surrounding environment, the layer of earth, and the formation of the volcano

Based on the analysis of the answer questions, obtained data that all students can explain the definition of the scientific method, and provide examples in constructing knowledge about the earth. The scientific method is a systematic procedure that is widely used by experts in constructing scientific knowledge. The scientific method in studying the earth is the steps taken to study the earth through the identification of problems, gathering information (researching), making hypotheses, testing hypotheses, analyzing data, and drawing conclusions. However, the test results show that only a small proportion of students, around 30% of students can explain how the scientific process in detail if related to environmental phenomena. Some explanations given by students are described in the following paragraphs.

### *3.1. Tsunami on Honshu Beach, Japan*

An example of knowledge about earth science obtained through the use of scientific methods is the tsunami that destroyed the coast of Honshu Island on January 27, 1700. In this event, scientists did not yet know when the disaster occurred, so they conducted research using scientific methods. In detail, students' answers to the scientific process can be described as follows.

1. Identify the problem
   What triggered the waves of this vast ocean?
2. Gathering information
   Some evidence shows that there have been significant earthquakes in the past along the coasts of Washington and Oregon. Some beaches in the area sink and drown the beach forest so that thousands of trees die.
3. Develop a hypothesis
   When alive, every year, trees show the existence of new tissue rings called annual growth rings.
4. Test the hypothesis
   The coast of British Columbia to northern California is an area called the Cascadia subduction zone. The subduction zone is part of the outer layer of the earth that is under the other plate.
5. Analyze data
   Analyzing tsunami events and adjusting the data with leather rings on trees buried along the coast.
6. Draw a conclusion
   It was concluded that the dead or damaged trees occurred after August 1699 but before the spring of 1700. The evidence shows that the earthquake occurred in the same period as the tsunami at Honshu.

The results showed that many students, ten of fifteen students were able to describe the scientific process in determining the cause of the tsunami in Honshu. A description of the scientific process in determining the cause of a tsunami on the scientific coast has been described in several textbooks [5];[6]. Many prospective teacher students who answered correctly about the incident indicated that they had read and understood the scientific process of the book. Although student books cannot present all concepts that must be learned [4], they can facilitate and improve the learning process [1] so that students have a good understanding of the scientific process.

### *3.2. Effect of Acid Rain on Plants*

Experts apply scientific methods to determine the effect of acid rain on plant growth. In detail, students' answers to the scientific process can be described as follows.

1. Identify the problem
   Does acid rain affect the growth of living things like plants and animals?
2. Gather information
   In nature, there are many types of rain, one of which is acid rain. Acid rain can be defined as rain, which has an acidity level of less than 5.6. Acid rain can prevent global warming because it can reflect sunlight out of the Earth's atmosphere. As a result, the increase in the earth's temperature can be prevented. However, acid rain has other effects that are more dangerous than global warming. Acid rain can be caused by nature, such as volcanic eruptions and forest fires. Air pollution, sulfur combustion, and electricity generation can produce several dangerous gases such

as carbon dioxide, carbon monoxide, sulfur dioxide gas, and hydrogen sulfide. The excessive acid content in acid rain causes many losses.

3. Formulate a hypothesis
   Acid rain can cause the death of living things such as plants and animals because it affects the pH of the soil so that it impacts on plants and water.
4. Test the hypothesis
   An experiment was carried out by mixing water with sulfur (sulfur), then splashed it into the soil, plants, and water in fish ponds. After that, observe the effects that occur.
5. Data analysis
   Based on the results of data analysis, the results show that plants that are watered with acid rain after a few days, the plants rot and die. Fish in ponds that have been watered with acid rain, many fish die after a few days.
6. Formulate conclusions
   The experimental results concluded that acid rain can affect the growth of living things like plants and animals, and can even cause death.

### *3.3. The Formation of Toba Lake*

Experts apply scientific methods to determine the process of the formation of Lake Toba. In detail, students' answers to the scientific process can be described as follows.

1. Identify a problem: how the Toba lake is formed.
2. Gather information
   Found a vast spread of volcanic dust, found almost all over the world. The distribution of dust comes from an ancient supervolcano eruption that leads to Mount Toba. It was found that the same volcanic ash molecule forms in 2100 points of the caldera crater, which is now the lake of Toba in Indonesia up to 3000 miles from the source of the eruption.
3. Make a hypothesis
   Lake Toba is the result of the eruption of the Mount Toba supervolcano. Volcanic material spewed out by Mount Toba is estimated to spread throughout the hemisphere.
4. Test the Hypothesis
   Some experts explain that the structure of the giant volcano or Toba supervolcano in North Sumatra, which is the most dangerous giant volcano on earth. Based on seismic observations made by experts at a depth of 100 meters below the lithosphere plate that formed liquid magma currents that continue to rise to the surface. Then, the existence of a magma bag with a volume of 50,000 $km^2$, which is located beneath Lake Toba. Giant volcanic eruptions occur when the pressure in the magma sac reaches a critical point. In that case, magma rises and spits out liquid on the surface of the earth. Lake Toba is currently the largest volcanic lake in the world that formed around 75.00 years ago.
5. Analyze the results
   Based on the results of the study, some evidence concludes that Lake Toba is a volcanic lake formed by the eruption of an ancient mountain super volcano, Mount Toba, and its impact is estimated to reach the entire hemisphere. Also, research on the potential of the Toba gull eruption shows that Mount Toba has enormous potential for eruption.
6. Draw conclusions
   Lake Toba is a volcanic lake formed by the eruption of an ancient mountain super volcano, Mount Toba, and its impact is estimated on the entire hemisphere. One impact that arises is that there is continuous rain so that the eruption hole filled with water to form a lake.

The ability of students to describe the scientific process about the effects of acid rain on plants and the formation of Lake Toba including the low category. Many students who have not been able to describe in detail how the process of these two events. It can be caused by the lack of learning resources that discuss how these two scientific phenomena occur. Also, students are never invited to do the science process outside the classroom can also be the cause. Students must often be involved in inquiry activities in order to have knowledge and skills in the inquiry process [11] or facilitated with learning assistance [10].

## 4. Conclusions

The results showed that the ability of prospective science teacher students to provide examples of the scientific process to study the environment was included in the satisfying category. However, most students have not been able to explain in detail the steps of the scientific process. For this reason, it is necessary to make learning innovations that direct students to be able to carry out the earth science process. One alternative learning process that can be implemented is to invite students to conduct science processes in natural laboratories in the surrounding environment. For example, determining the type of soil suitable for a cactus plant can be taught to students by carrying out experiments outside the classroom.

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