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Prospective Teachers' Scientific Literacy through Ethnoscience Learning Integrated with the Indigenous Knowledge of People in the Frontier, Outermost, and Least Developed Regions

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Abstract

The indigenous knowledge in the frontier, outermost, and least developed regions has not been explored thoroughly as an application for Ethnoscience learning. Therefore, this research aimed to explore the indigenous knowledge and its application to measure prospective science teachers' scientific literacy through Ethnoscience learning. The prospective science teachers joining the Ethnoscience subject were employed as the research samples. A descriptive research method with a qualitative approach was applied for this study. The indigenous knowledge in the frontier, outermost, and least developed regions, i.e., Sumatra, Java, Sulawesi, Kalimantan, and Papua, is a potential learning source for exciting science learning and providing the opportunity for prospective science teachers to develop scientific literacy. Based on the results, 13 students achieved grade A, whereas 14 students got AB, and the other 4 students achieved B. All prospective science teachers were good at analytical thinking, problem-solving, and communicating. They also gained knowledge from the analysis results, which made them master the problem-solving skill. In conclusion, the indigenous knowledge of the frontier, outermost, and least regions integrated with Ethnoscience learning can improve the prospective science teachers' scientific literacy effectively.

Keywords*:* Ethnoscience, Indigenous knowledge, Scientific Literacy

INTRODUCTION

Local activities of rural communities living in the frontier, outermost, and least developed regions could be employed as a science learning source. There is hidden knowledge in those indigenous activities which require a particular strategy to explore as the source of Ethnoscience learning. The local community's indigenous knowledge is essential as the basic knowledge for prospective science teachers to preserve the culture and pass it to the next generation. The local knowledge is sometimes missing and prone to extinction. Therefore, an effort to explore the hidden knowledge behind local communities could be engaged in science learning. The knowledge has the potency to be the source of science learning and could be an alternative to applying the "back to nature" concept.

In science learning, some skills are needed to achieve practical learning. One of them is the skill in finding information (Michel & Neuman, 2016; Pahrudin et al., 2019). Also, there are various sources of learning; therefore, special skills, including self-awareness of information, are required to be mastered in order to get appropriate information sources. This self-awareness is also essential for choosing the right learning source to get the appropriate and correct information. Thus, the skill in finding highly trusted information is also vital since there is an abundant number of learnings and information sources. In line with this, Sinaga et al. (2017) and Darnell et al. (2017) stated that science learning resources are not only limited to textbooks but also research findings published in either printed or electronic media. In this regard, choosing suitable learning resources become part of a learning strategy influencing the success in learning science (Clough, 2018).

A study found that students in three science education study programs of teacher training universities in Indonesia tend to read only textbooks to explore the indigenous knowledge in Ethnoscience subject. Unfortunately, this fact also revealed that textbooks provide inadequate indigenous knowledge to achieve the expected learning outcomes. Parmin et al. (2016) and Tom et al. (2019) stated that a direct exploration of the local community intends to get adequate information to cope with this problem. By engaging with the local community, the hidden knowledge could be revealed analytically. The analytical thinking skills will be the measurement standard to reconstruct the indigenous knowledge into scientific knowledge. Moreover, Krathwohl & Anderson (2010), McIntyre (2017), and Roksa et al. (2017) found that the characteristic of analytical thinking, in this regard, is the

ability to gather information from various sources.

Ethnoscience is a medium to reconstruct indigenous knowledge into scientific knowledge. The results of scientific investigation on indigenous knowledge as empirical evidence have been published in numerous scientific journals, among other are Australian Journal of Indigenous Educat ion, Journal of Indigenous Wellbeing, International Journal of Indigenous People, Journal of Indigenous Research, The International Indigenous Policy Journal, International Journal of Indigenous Health, Journal of Indigenous Studies, and First Nations and First People' Cultures. These articles could be referred to as the scientific sources to enrich the prospective science teachers' knowledge, especially in Ethnoscience subject. Kim & Baylor (2016), Webb et al. (2018), and Noguez et al. (2019) concluded that the integration of learning with research results is adequate to make the contextual learning source and can be applied to develop necessary research skills. Therefore, the findings of these papers are regarded as adequate sources of learning.

The scientific knowledge as the result of the indigenous knowledge reconstruction could be obtained through a direct exploration of the knowledge (Sumarni et al. 2016; Haviz et al. 2018). The exploration technique includes observation and direct interviews with the local communities. The interview with the local community is excitingly done. Moreover, the idea of integrating the local community representative as the speaker in the classroom to perform in-depth exploration with the source is also interesting as a deep exploration will be done thoroughly with a high level of trust value.

Most people tend to doubt the truth of indigenous knowledge since traditional communities remain to possess it. They doubt the correctness of the information. Therefore, Ethnoscience learning appears to overcome this problem, and students will have strong concern and belief in the existence of indigenous knowledge.

The development of scientific literacy is possibly achieved through the contextual learning model by conducting studies using the local community (Soobard & Rannikmae, 2011; Dewi et al., 2019). Besides, the use of formal learning resources from local communities in the form of a scientific literacy curriculum is essential to develop critical thinking and behavior (Bybee, 2014). Critical thinking and behavior are possibly formed from the practice of conducting the investigation. According to the findings of Huang & Asghar (2016), the social culture, as the object of

the study, is the main component of inquiry in science. Ethnoscience learning integrates the indigenous knowledge of society with science as scientific knowledge, which requires a direct study of community activities. Parallel with this, Sjöström (2018) stated that scientific literacy could be obtained by integrating science as scientific knowledge with traditional community traditions that are following the characteristics of scientific objects. Prain & Waldrip (2010) and Faisal & Martin (2019) investigated that scientific literacy is needed for prospective science teachers as a provision to facilitate student learning that integrates science with local wisdom.

Based on the previous findings as well as the results of the initial study conducted, the objective of this research was to reveal the prospective science teachers' scientific literacy through ethnoscience learning integrating indigenous knowledge explored from the frontier, outermost, and least developed regions. In this study, the indigenous knowledge of the frontier, outermost, and least developed regions was obtained through exploration with observational studies, interviewing the native community speakers, and information retrieval from cyberspace. The scientific literacy, in this research, measured knowledge, analytical thinking, problem-solving, and written communication. Therefore, this study did not only examine the indigenous knowledge but also applied the knowledge as a study in Ethnoscience learning.

METHOD

The research was conducted using a descriptive method with a qualitative approach. The scientific literacy measured in this study included knowledge, analytical thinking, problem-solving, and written communication that adopt scientific literacy indicators from the Program for International Student Assessment/PISA (Anderson et al. 2007).

The research target included the prospective science teachers of the Integrated Science Education Study Program, Universitas Negeri Semarang, who enrolled in the Ethnoscience subject. The total number of the students were 31 (2 male students and 29 female students). Geographically, the students were varied based on their origin, starting from Sumatra, Java, Sulawesi, Kalimantan, and Papua Island. The students' origin supported the learning process of Ethnoscience since the subject requires the exchange of indigenous knowledge information.

The indigenous knowledge was measured through a test consisting of 12 essay items. Each item has a stimulus either in the form of a picture, phenomenon, or description of a

particular knowledge explored from the people settling in the frontier, outermost, and least developed regions. The range of scores used was 0 to 100 for each question.

The indicator of knowledge, i.e., the Ethnoscience concept and application of the concept included the findings of indigenous knowledge in the frontier, outermost, and least developed areas. First, the analytical thinking skills were measured through the use of the same test questions employed for testing the indigenous knowledge. The example of the test item is as follows:

'Bakar Batu' (burning stone) tradition of Papua, as shown in the Figure, is revealed as one of the essential cooking rituals of the community in a village aiming at celebrating customs that unite local communities. Not all types of stones are used, but those found in their surroundings, dark in color, and hard. Why are these types of stone chosen?

There are five C4 type cognitive problems to measure analytical thinking skills. The problems integrated the facts obtained from the discovery of indigenous knowledge as the stimulus. Then, the students were asked to analyze the scientific concepts of indigenous knowledge and also the potential products that can be developed from the knowledge. Second, the next aspect was the problem-solving skill assessed using worksheets. The students were directed to solve the problems that arose as a result of the local community's indigenous knowledge in the frontier, outermost, and least developed regions, which begins to disappear. Third, the reconstruction of indigenous knowledge into scientific knowledge by measuring problem-solving skills. Furthermore, prospective science teachers wrote the report to measure their written communication skills. The written report was arranged based on the information in the electronic information sources. The score was given by evaluating the discussion session.

The data on the students' knowledge was graded in letters. Score A is > 85, AB ranges from 84-80, and B is 79-75. The analytical thinking skill was measured from the prospective science teachers' answer by scoring them from 0-100. The analytical thinking skill was classified referring to Purwanto's (2008) category, as shown in Table 1.

Table 1. The Category of Analytical Thinking Skill

Range of Score	Category

N > 80	Excellent
60 < N ≤ 80	Good
40 < N ≤ 60	Fairly Good
20 < N ≤ 40	Poor
N ≤ 20	Very Poor

The problem-solving skill aspects were measured using the worksheets. The measurement of analytical thinking skills applied the score range from 0 to 100. Arikunto's (2006) criteria were applied to measure the problem-solving skill, as presented in Table 2.

Table 2. The Category of Problem-Solving Abilities

Range of Score	Category
80 – 100	Excellent
61 – 80	Good
41 – 60	Fairly Good
21 – 40	Poor
0 – 20	Very Poor

Then, the assessment of written reports, regarding the results of indigenous knowledge exploration through various electronic learning sources (scientific journal articles), was performed by giving a maximum score of 100. The contents of the report weighed 70%, the introduction part weighed 20%, and the conclusion weighed 10% of the total assessment. The four indicators of scientific literacy in this study were analyzed in every aspect.

RESULTS AND DISCUSSION

The prospective science teachers' Ethnoscience knowledge is shown in Figure 1.

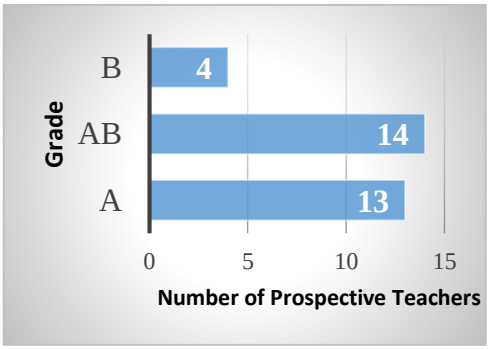

Figure 1. The Students' Ethnoscience knowledge

The results showed that the number of students who obtained A-grade was 13 people, AB were 14 people, and B was 4 people. There were no students who scored below 75. It means that the concept of Ethnoscience is well accepted and well understood. As for the results of analytical thinking, measurements are presented in Table 3.

Table 3. The prospective science teachers' analytical thinking skills

Range of Score	Number of Students	Category
N > 80	21	Excellent
60 < N ≤ 80	7	Good
40 < N ≤ 60	3	Fairly Good

Qualitatively, the prospective science teachers' thinking skill has been good, keeping in mind that the students categorized as 'excellent' and 'good' were more than those in 'enough' category. Most students had good analytical thinking skills because no one scored in the category below Fairly Good. Next, the assessment of

prospective science teachers' written report was provided through the worksheet assessment as generated in Table 4.

Table 4. The Prospective Science Teachers' Problem-Solving Skill

Range of Score	Number of Students	Category
80 – 100	12	Excellent
61 – 80	9	Good
41 – 60	8	Fairly Good
21 – 40	2	Poor

The prospective science teachers' problem-solving skills varied from poor to excellent category. After a qualitative analysis, the study resulted in some exciting solutions that can be formulated based on the research objectives;

1. There should be a massive exploration of all indigenous knowledge possessed by tribes and communities throughout Indonesia as an effort to save national wealth.
2. The effort to mobilize schools in the frontier, outermost and least developed regions as a mean of exploration of knowledge possessed by traditional communities are needed since teachers and students living in there are best aware of the uniqueness of their respective regions.
3. The transformation of indigenous knowledge in local communities to scientific knowledge will be less advantageous if the students only learn the knowledge. The best way is by developing a product with the benefit of humankind.

The prospective science teachers showed their analytical thinking skills through a report on the results of indigenous knowledge exploration from scientific articles. The scientific literacy indicators were analyzed in each aspect. According to the results of this research, scientific literacy indicators data indicated that the use of indigenous knowledge is a crucial key as the strategy of concept mastery, analytical thinking, problem-solving, and communication skills improvement.

Also, there was an increase in prospective science teachers' Ethnoscience knowledge in both categories after conducting the learning process by employing indigenous knowledge as a learning resource. Based on the analysis of student answer sheets, they have comprehended the basic concepts of ethnology in a good category because they were able to answer the question correctly. For example, students could describe the answers thoroughly on the questions related to indigenous knowledge. In this research, in addition to using learning resources from various results of the reconstruction of indigenous knowledge that has been published in various journals, Ethnoscience learning also presented

resource persons from traditional community members. The resource persons in question are students who are also currently studying from the higher education affirmation program from the various frontier, outermost, and least developed regions. The presence of several speakers is a particular concern for students who have been getting information only from websites. Therefore, the presence of informants as actors in traditional society is believed to have an impact on the level of student confidence in the object being studied in learning Ethnoscience. For information, the courage to develop learning resources remains to be an issue in science learning that is oriented to achieving complete competence (Mardiana & Cahyani, 2018; Adhi et al., 2018). This research provides alternative solutions to increase the courage of prospective science teachers in developing teaching materials.

The analysis results of C4-type cognitive items given to students to measure scientific literacy in analytical thinking skills showed that the students could analyze the stimulus questions presented. The stimulus used is the indigenous knowledge exploration outtakes in the frontier, outermost, and least developed regions. This result is consistent with the opinion that the ability to answer questions demanding analytical thinking skills is very dependent on the presentation of the stimulus obtained from activities while learning (Irwanto et al., 2017; Tiruneh et al., 2017). In this case, the students have analyzed the concepts of science contained in the indigenous knowledge, which is attached to the questions as a stimulus. Variations in learning resources can provide opportunities for students to compare information from electronic journal articles. Many interesting facts are found from various indigenous knowledge researches in Papua, West Papua, Maluku, and Kalimantan. The various data presented in the article, which was used as a learning resource, is proven to be able to train the students' reasoning skills. This ability can be achieved by reading the findings through a deductive or inductive approach. In line with this, Nuswowati & Purwanti (2018) stated that learning science to develop analytical skills requires learning resources by comparing data from various research findings. In this study, the students were also invited to predict products that have the potential to be developed from indigenous knowledge. If the indigenous knowledge is converted into scientific knowledge, it can potentially be developed into a product such as herbal products for beauty and medicine, as well as foods processed in a modern way. It supports the opinion that scientific literacy can develop if a person

can integrate science with its application (Ristina et al., 2019). In this study, scientific literacy increasingly developed when it provides opportunities to analyze learning resources, which also contain findings supported by research data.

Furthermore, the indigenous knowledge from the frontier, outermost, and least developed areas can be used to hone problem-solving skills for prospective science teachers. However, along with the development of technology and information, indigenous knowledge is threatened to fade and disappear. Therefore, we need a solution to the problem of the loss of indigenous knowledge because it is no longer applied and known to the indigenous people. This problem can be used as an issue to measure prospective science teachers' problem-solving skills. In this case, prospective science teachers were more dominant in providing an alternative to solving this problem by changing indigenous knowledge into scientific knowledge. The students' ideas show the critical spirit of young scientists by providing solutions in the form of laboratory testing of various objects believed in indigenous knowledge. Tho & Yeung (2016) explained that the results of laboratory testing on indigenous community knowledge could produce knowledge that has high confidence. The problem-solving skill from the data obtained shows that students can provide scientific solutions to the proposed problems.

The prospective science teachers also have excellent oral communication skills. It was proven based on the values given in the discussion section of the report. They showed a discussion about the use of research results published in various journals, which could provide experience to the students not only to find out other people's findings but also to compare various findings. Supporting this finding, Nofiana & Julianto (2018) stated that to improve scientific literacy, and students can use helpful local learning resources. The communication skill of prospective science teachers was measured based on the depth of discussion written in the scientific reports. The discussion analysis showed that the students dared to develop ideas, which becomes an indicator of scientific literacy (Rusilowati et al., 2016; Kurniati et al., 2016). Therefore, it concluded that the prospective science teachers' scientific literacy increased after they employed indigenous knowledge as part of the Ethnoscience study.

CONCLUSION

The superiority of indigenous knowledge in the frontier, outermost, and least developed regions could create an attraction for prospective science teachers to learn, explore, and test the

indigenous knowledge. The knowledge gained from the results of the frontier, outermost, and least developed community's indigenous knowledge analysis has improved the students' problem-solving skills. Also, the mastery of knowledge gained from the activity of finding learning resources has a role in the development of student ideas as outlined in written form. Nevertheless, this research did not reveal the form or examples of indigenous knowledge used because it will be part of another article. This study also did not explore the students' attitudes through interviews so that the attitude of the research objectives could not confirm the data produced. Therefore, further study is needed through in-depth interviews to obtain complete and comprehensive data.

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