Ethnoscience-based science learning in elementary schools

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Abstract. Indonesia is rich in cultures encompassing the understanding of various values that must be learned by students. Learning based on a cultural perspective relating to natural phenomena in life is called ethnoscience. Surabaya as a metropolitan city has various cultures including Remo dance, batik, rujak cingur, lontong balap, fish preservation, and semanggi. There are many scientific concepts that can be explored through these cultures. This study aimed to explore scientific concepts through these cultures in elementary schools. This study used descriptive research design with transformative, verification, and knowledge conceptualization stages. Results showed that many scientific concepts extracted from ethnoscience, for instance in rujak cingur, were related to the concepts of friction force, healthy food, and physical and chemical changes. With ethnoscience-based science learning, students are expected to learn happily and master the science concepts easily.

1. Introduction
Indonesia’s rich cultures contain values that must be learned by students. The cultures are in the form of different languages, traditional clothes, traditional foods, and regional songs. This diversity can be a learning source and knowledge for students.

Learning based on a cultural perspective that deals with natural phenomena in life is well-known as ethnoscience. Ethnoscience is a form of people's understanding of nature and culture [1]. Furthermore, Khusniati states that ethnoscience is a science studying how knowledge is obtained based on cultures existing in society [2].

The teaching of science is expected to be a vehicle for students to learn about themselves as well as their environment, and to be able to apply everything they know in everyday phenomena. In Curriculum 2013, learning conducted in elementary schools is developed thematically and appreciates ethnoscience in its learning activities. Integrating ethnoscience in a learning process could be undertaken by utilizing society’s cultures.

Sudarmin [3] explains that the appropriate approach used in teaching science in Indonesia is ethnoscience. Sarfiyo and Pannen [4], convey that this approach is a strategy to create a planning and learning environment that integrates ethnoscience in science learning activities. Ethnoscience learning is very important in understanding scientific knowledge that develops in society, which is then transferred to scientific knowledge in a learning process.

Empirical evidence shows that the science teaching model integrated with ethnoscience can be used in a learning process, improve student’s learning outcomes and critical thinking skills, and enhance
student’s scientific thinking skills in local culture [5][6][7]. Suryanti et al. suggest that teaching materials integrating local wisdom in a learning process can improve students' scientific literacy skills [8].

Surabaya as a metropolitan city has various cultures including remo dance, batik, rujak cingur, lontong balap, fish preservation, and semanggi. There are many scientific concepts that can be explored through these cultures. This study aimed to explore scientific concepts through ethnoscience in science learning in elementary schools.

2. Methods
This study used descriptive research design with transformative, verification, and knowledge conceptualization stages. At transformation stage, the disclosure of scientific knowledge developed in society was transferred to scientific knowledge. The sources of the data were obtained by conducting interviews with informants using interview guidelines. The data obtained were analysed descriptively.

3. Results and discussion

3.1 Transformation of Semanggi Batik
Semanggi Batik was one of Surabaya icons. In semanggi batik, the clover plant was not processed into batik or used as batik colours, rather, its shape was used to be the batik motifs. Apart from not destroying the plant, it could also preserve clover leaves and introduce them to wider community. There were two techniques in making semanggi batik namely writing and stamp techniques. Table 1 shows the results of the semanggi batik transformation.

| Science in Society’s Perspectives | Scientific Science |
|----------------------------------|--------------------|
| Making batik using canting       | Canting was made of copper or brass with one pointed-end used as a writing tool and the other part was used for doing canting from the melted wax. The use of copper or brass in canting was because they were a good conductor capable of storing heat, so that the wax liquid in canting would not cool down quickly and freeze. Wax could undergo changes in its form, that is, it could melt due to heat exposure and might freeze when cooled. |
| Making batik using wax           | The wax used was the normal form and white wax. The main raw material for making wax was wax itself. The wax had resistance to water, melted when heated, and froze when cooled, did not break easily when dried, covered areas that were not exposed to color, and was able to stick to the fabric perfectly. Just like the canting, the stamp tool was made of brass and copper. It would be dipped on a hot wax. Copper and brass were used because these objects were conductors that could store heat. Thus, the wax remained in its liquid form and could stick to the fabric. |
| Making batik using a batik stamp | The concept of pressing that occurred in the stamping mode changes was a liquid wax that was not pressed firmly and correctly would result in an unclear and untidy pattern. Meanwhile, if it was pressed firmly, the resulting pattern would look neat and clear. |

Stamping was done by pressing the stamp tool firmly.
Table 1. Cont.

| Process                                      | Description                                                                                                                                                                                                 |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dipping the cloth in the dye solution        | In this process, the cloth that already had a batik motif was dipped in dye solution to color the batik cloth. In the process of dyeing the fabric, a capillary process occurred. Capillary was an event of rising and falling water in the capillary tube. The dye could seep into the fabric due to the adhesion force between the dye molecules with a hook and the cohesion force between the dye molecules. The adhesion and cohesion forces determined the surface tension of the dye solution. Then, the surface tension would affect the amount of increasing or decreasing dye solution on the fabrics. This capillary process caused the color of the fabric to change according to the color of the dye used. |
| Drying the cloth under the sun so that it could dry quickly. | In the drying process, there was a change in the form of a substance caused by heat transfer without an intermediate substance called radiation. The change in the substance was evaporation, a change from liquid to gas. This evaporation process caused the water molecules contained in the fabric fibers to evaporate, so that the fabric dried. |

Table 1 shows that, in semanggi batik ethnoscience, there were scientific concepts inherent in society’s science concept and could be used in teaching scientific science. The concept of scientific science included the use of a conductor as a canting tool and a batik stamping tool, an understanding of the nature of batik wax which could undergo changes in forms, coloring techniques, and drying batik clothes.

There were many studies that used batik as an ethnoscience-based science learning. Tresnawati used Ciwaringin written batik as a means of learning science based on local wisdom [9]. She stated that local wisdom-based science learning could foster a love for community science which had implications for environmental conservation and balance [9]. In addition, the development of learning modules based on ethnoscience could also improve student’s learning outcomes [10].

3.2. Transformation of Remo Dance

Remo dance was a traditional dance opening the Ludruk show. The dance had the concept of force and motions in several movements, starting from the movements of the hands, feet, head, and body. The science concept in Remo dance was gravity and muscle force. Table 2 shows the results of the Remo dance transformation.

| Science in Society’s Perspectives | True Science                                                                                                                                                                                                 |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| *Ngrancik* movements and *Gedruk Lombo* hand-movements | This referred to the downward fall of *sampur* in *ngrancik* movements and gedruk lombo hand-movements even though the *sampur* was moved to any directions. *Sampur* that always fell down showed the earth's gravitational force. Earth's gravitational force was an attraction coming from the earth's core. The existence of this force caused any objects thrown in any directions to fall down. |
Table 2. Cont.

| Ngracik movements | In ngracik movements, there was a movement of heel lifted backward alternately right-left. Ngracik movement was moving the heel to be lifted backward alternately right-left. In order to be able to perform Remo dance movement that involved all proper limb movements, of course, it could not be separated from the force generated by the muscles. Muscle force was the force produced by the muscles of the body. It was very flexible because it was controlled by human coordination. With this muscle force, humans could make movements. |
| --- | --- |
| Gongseŋ stomped hard | Gongseŋ in Remo Dance would produce a jingling sound during the Gedruk Lombo movement, a movement of stomping the right foot twice to the earth so that the gongseŋ would sound according to the number of stomps of the feet. The gongseŋ sounded because it experienced vibrations that resulted from stomping the feet. Generally, sound was produced by vibrations, namely in the form of a stomp and could propagate through solid, liquid, and gas medium. When the gongseŋ was sounded, the medium for propagation was the gongseŋ itself which was a solid substance. The sound could be heard because the sound also traveled through the gas medium. |
| Teer necklace, rapek, and gongseŋ looked shiny. | Gongseŋ could look shiny because there was a process of light reflection. Reflection was the process of re-emitting light from the surface of an object that was exposed to light. The examples of objects that could reflect light were beads on teer necklaces, rapek, and gongseŋ. |

In addition, Remo dance was only taught in art lessons or extracurricular activities. The importance of teaching Remo dance was not only limited to the introduction and preservation of culture, but there were also scientific concepts that could be taught to students. As described in Table 2, in Remo dance, there were scientific concepts which included the concepts of force, sound, and movement. Kartono and Bujang argue that science learning could be developed from the advantages and uniqueness of an area, including its cultures [11]. Science learning based on ethnoscience was a learning process by utilizing local cultures [12].

3.3. Transformation of Rujak Cingur
Mbak Ida's stall was famous for its rujak cingur and had operated since 1997. The famous rujak in this stall made many state officials visit to eat rujak (vegetable salad) in this place and this had been documented by the seller. According to the seller, what made her rujak different was the delicious, original, and large cingur along with the delicious paste. Table 3 explains the results of rujak cingur transformation.
Table 3. Transformation of Rujak Cingur.

| Science in Society’s Perspectives | Scientific Science |
|-----------------------------------|--------------------|
| Traditionally grinding the spices using lemper made of stone so that the result became softer quickly. | Stone had a rougher surface. The rougher the surface of a plane, the greater the friction force. Because the value of the friction force produced was large, it would speed up the spice grinding process. The friction force was a force that occurred on two surfaces of objects touching each other. The friction force was very much influenced by the roughness of an object. |
| Giving a kluthuk banana so that it tasted delicious and mat, so the spices were easy to mash. | Kluthuk banana had a pleasant taste because it contained tannin and saponin. This taste when combined with the spices in rujak cingur would produce a distinctive taste. In addition, tannin and saponin substances were also able to strengthen the digestive tract and suppress the growth of pathogenic bacteria that had the potential to cause rujak cingur to produce a mat texture when crushed. The nature of the mat also played a role in increasing the friction force to accelerate the spice grinding process. |
| The vegetables were medium cooked. | The vegetables used as complements to rujak cingur were medium cooked. Such cooking way was carried out by boiling them. Vegetables that were boiled too long would destroy the vitamin content inside them and caused the vitamins contained in vegetables to dissolve in water. So, the longer the vegetables were boiled (until cooked), the more vitamins were wasted. |

Rujak cingur, besides having a delicious taste, was also rich in scientific concepts that could be taught to students. In accordance with Table 3, in rujak cingur, there were concepts of force, human digestive system, and healthy food developed in society’s science perspectives. There were many studies that constructed ethnoscience-based science learning into scientific science used in a learning process. Some of the ethnoscience that had been used in research included the process of making brown sugar in Kendal [13] and the process of making salt [14].

To better understand students about the scientific science contained in ethnoscience, experimental activities could be undertaken. For example, the concept of friction occurred in the process of grinding spices used a stone plate. Stone had a rougher surface. The rougher the surface of a plate, the greater the value of the friction force. Because the value of the friction force produced was large, it would speed up the spice grinding process. This fact was supported by a research conducted by Darmanto et al. [15], which concluded that the rougher the specimen surface was, the greater the friction force. In line with this, Fitrianto et al. stated that the rougher the surface of an object, the greater the angle of friction and the coefficient of friction. The following is an example of an experimental movement in the classroom (See Figure 1) [16].
In the rujak cingur ethnoscience, there was also the concept of healthy food. This concept appeared in the process of boiling vegetables into medium level. Vegetables that were boiled too long and were over cooked would damage the vitamin content inside them and caused the vitamins contained inside them to dissolve in water. Moreover, healthy food also contained other substances needed by the body, such as carbohydrates, protein, fats, and minerals. Experimental activities that could be carried out by elementary school students that were in accordance with this concept and content were to test the carbohydrate, protein, and fat contents of the raw materials for making rujak cingur.

The experimental method was a way of presenting learning materials where students conducted experiments, observed the process, wrote the experimental results, and presented the results of the experiment by being evaluated by the teacher [17]. When students did an experiment, they would experience, know, and prove themselves something they had learned. The application of the experimental method in science learning, besides being able to improve teacher performance, could also increase student’s learning activities [18]. Oviana and Maulidar stated that the use of experimental methods could improve student’s learning outcomes [19].

These facts showed that ethnoscience contained scientific science that could be used in a learning process in elementary schools. Suryanti [8] stated that teaching materials that integrated ethnoscience in a learning process could be used as an alternative solution for learning resources in elementary schools. The use of the surrounding environment as a learning resource would make students easier to understand a concept because they could find the real conditions around them, see directly, feel, and apply the knowledge they had in everyday life. Barlia, stated that learning directly from one's own experience was more effective than just reading a book [20].

4. Conclusion
The results show that there are many scientific concepts that can be extracted from the ethnoscience of Surabaya city, for example, in Semanggi Batik that is related to the concept of living natural resources, changes in the form of objects, and force. With ethnoscience-based science learning, it is expected that students will be more attracted to learn and that the knowledge can easily be permeated student’s minds.

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