The Reconstruction of Pekalongan Batik Knowledge as Scientific Knowledge in Chemical Education

Ratna Kumala Izza* and S. A. Indyah
Yogyakarta State University, Indonesia

*Email : izzaratnakumala.2017@student.uny.ac.id

Abstract. This research was aimed to reconstruct the indigenous knowledge of Batik Pekalongan as chemical awareness that can be used for teaching and learning resource. This study used descriptive research of a qualitative approach through scientific assessment. Data was collected using interview, direct observation, and documentary techniques to four natives who lives and work as traditional Batik craftsmen in Buaran, Pekalongan, Central Java, Indonesia. The documentation was about the traditional making process of Batik Pekalongan. The collected data hereafter was analysed and interpreted as scientific knowledge. The conclusion was that there were some chemical educations from the process and waste of Batik Pekalongan.

Keywords: Batik Pekalongan, Indigenous Knowledge, Chemical Education.

1. Introduction
Batik is one of the culture that Indonesia has. Indonesia has been known for the batik since the 4th or 5th century. Officially cultural subjects received international recognition from UNESCO as an intangible cultural representative human heritage belongs to Indonesia and in accordance with [1] about the National Batik day on October 2. Batik is an art by writing, painting on cloth, through the long process. Batik has been known as art and craft of ancient traditions for centuries. Batik is made by drawing dots and lines against using wax through a tool called canting [2]. Batik was an exclusive art in ancient Jewish tradition because it was only provided and used specifically for the royal family. Today, batik is not only used as a artwork but also used to a variety of activities, supposing wrapping a newborn baby, the wedding clothes, blankets cover the bodies, or in the context of indigenous mitoni and so on. Thus, the batik is artwork that can be used as an identity.

Indonesia has Batik as one of the cultural diversity country. According to Kamus Besar Bahasa Indonesia, culture is interpreted as mind. A simple and traditional knowledge that existed at the time of ancestors was then used as a way to live for centuries and passed century from generation to generation. In addition to increasing the sense of nationalism, harmony and morals to build identity [3], culture can also be used as a source of educational knowledge. The rapid development of science and technology gives impact to educational development and produce formal science knowledge commonly referred as Western Modern Science [4]. Formal science knowledge is provided through formal education at school. The learning process is usually integrated by involving real-world contexts. The real-world contexts learning process is directly involves students to make the connection between knowledge that has been learned with the context of the real world or the surrounding environment. The purposed was to make students more understand the scientific knowledge and join up with...
society. Contextual approach had a positive influence on students' level of chemical literacy by discussing issues or topics of personal experience [5]. Not only in chemical education, contextual clinical situations in the medical world have a positive influence on assessment results [6], critical thinking skill in decision making, and better understanding. Using the environmental context as a learning source can be interpreted as ethnoscience learning approach.

Ethnoscience is used by integrating indigenous knowledge of culture, morals, language, customs, and technology created by certain communities that contain scientific knowledge [7], [8]. Although using culture-based learning in chemistry is recommended, it is less concerned with the local culture that develops in society [9]. As a result, young generation had less aware and care about the culture of ancestral heritage. In modern-day, triggering students' social interaction ability is decreasing [10]. For this reason, students are expected to be able to utilize the community and the environment as a source of learning, to blend in with the community and environment in order to understand natural phenomena. The scientific literacy ability in the community and environment also called chemical literacy ability.

Chemical literacy is a basic ability in schools that emphasizes the application of chemical knowledge in daily life that is appropriate to the society. As a basic ability, chemical literacy is considered as the main point for changes in chemistry learning. It is proven that chemical literacy originating from scientific literacy is included in one of the 21st century capabilities required among 16 skills identified by the World Economic Forum [11]. Chemical literacy ability is not only to understand the chemical concept, but also understand domain of chemical issues in the contextual and develop through technology [12]. Because of the importance of the chemical literacy ability and cultural literacy as an identity, the process of learning in schools is recommended to incorporate elements of culture, given the rapid changes in globalization. Although batik culture is famous in the international area, many students do not understand the process of making batik. This is one of the obstacles faced because in the process of making batik contained the original science of society that has not been formalized into scientific science.

The purpose of this research is to identify and describe the indigenous knowledge of the community about the process of making Batik into formalized scientifically knowledge. The description results of the interpretation in this study can be used as an alternative learning source in chemical education. In the future, the hope that indigenous science in cultural elements can continue to be developed and used to support education and encourage students to love local cultures.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Research Method

The purpose of this research was to analyze, reveal the indigenous knowledge of the community and reconstruct that making Pekalongan Batik knowledge into scientific knowledge. This research used qualitative descriptive research. Primary data was taken with interview techniques, direct field observations, and discussions with craftsmen. While secondary data was obtained from the documentation of the making Pekalongan Batik process. Interview guide guidelines instrument was used for in-depth interview technique. Pekalongan Batik was the research object and four native people of Pekalongan as respondent to get information about the indigenous knowledge about the making Batik process. Three speakers worked as batik craftsmen in the Pekalongan Batik home industry while another were batik craftsmen also and worked as a tour guides at the Batik Museum in Pekalongan. The chosen research location was Buaran Village, Pekalongan City, Central Java, Indonesia. The location was chosen because Buaran Village is one of the villages in Pekalongan where most of the residents have businesses and work as original batik craftsmen in Pekalongan. The focus in this study is the process and waste in batik making process. In addition to interviews, data was obtained by direct observation of population activities in making batik as a livelihood. Then the data was triangulation analyzed triangulation by reviewing or evidence collected scientifically which was reconstructed as
the research result in scientific knowledge sources to support the learning and teaching activities in local wisdom-based chemical education.

3. Result and Discussion

The observation and interview result conducted on batik craftsmen are known that the knowledge gained before building a business of Batik craftsmen gets oral knowledge from surroundings. Furthermore, they conducted an experiment to make batik several times to get maximum results. Knowledge possessed by Pekalongan Batik craftsmen is given orally from ancestors. The observation document of tools and basic ingredients for batik making can be seen in Figures 1, 2, 3, 4, and 5. Meanwhile, Figure 6 depicts part of the process of making Batik.
The results of the indigenous knowledge about the making batik process and the resulting waste has been interpreted into scientific awareness which can be seen in Table 1.

Figure 6. Part of Making Batik Process at Mr. H. Sodikun Home.
(a) Tasting/Nglowongi; (b) Nyolet; (c) Dasaran (basic coloring), Nglorod, and Washing; (d) Mopok; (e) Rentesan/Laseman; f) Drying; (g) Batik Product.
| No. | The Questions | Indigenous Knowledge | Chemical Education Reconstruction |
|-----|---------------|----------------------|----------------------------------|
|     |               | Tools | Ingredients | Making Batik Process | Waste | Tools | Ingredients | Making Batik Process | Waste |
| 1.  | What the tools are used in the making batik process? | Canting tulis/cap used to take wax that has melted because it is heated and used to form a pattern on the white cambric. | Canting tulis/cap made of copper metal, Cu (Cupper) is a good conductor metal [13]. | |
| 2.  | What the ingredients are used in the making batik process? | White cambric used as a basic material for batik, as a pattern formation. | Ender made of copper metal, Cu (Cupper) is a good conductor metal. | White cambric: made of cotton/fiber-based yarn spinning silkworm cocoons. Scientifically, cotton contains polymers cellulose, while fibers from silkworm cocoons contain natural proteins. [14] researched, fiber made from natural (Epipremnum aureum plant) which having good characteristics. Spectroscopy, X-Ray diffraction, thermogravimetric, scanning electron microscopy, and single fiber tensile test were used as technology. | Wax made of the excretion and metabolism of plants or animals. Scientifically wax is a lipid that has hydrophobic properties. |
|     |               | Wax | Gondorukem, bee wax, microwax, paraffin, resin. | Wax changes in the form of substances from solid to liquid, which is melting, occurs due to heating or increasing temperature and reaching the melting point. | |
3. How to make the dyes for batik?

- **Synthetic/reactive dyes:**
  - Frozen, indigosol, napthol

- **Indigosol dan salt**
  - The step to make the dyes:
    - **Step I**
      - Mixing dyestuff, custic and boiling water.
    - **Step II**
      - Salt by dissolving nitrite, air keras and water. “Air keras” can be replaced with a motorbike battery (aki).

- Synthetic dyes used to color the pattern on the fabric, so that the fabric has aesthetic and beauty value. Synthetic / reactive dyes have two stages in the coloring process in batik.

- Synthetic dyes has aromatic chemical structure which is difficult to eliminate because it has the relatively high stability.

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**Table:**

| No. | The Questions | Indigenous Knowledge | Making Batik Process | Waste |
|-----|---------------|----------------------|----------------------|-------|
|     |               | **Tools**            | **Ingredients**      |       |
| 1   | naphthol and saltor “asam base” | Step I | Mixing the dyestuff with custic soda, “sisik” or “soda api” to dissolves in boiling water. |       |
|     |               | Step II | To generate dyestuff using diazonium-R salt or yellow GC. |       |
|     |               | **Chemical Education Reconstruction** |               |       |
|     |               | **Step I** | Using boiling water to dissolve the Custic: sodium hidroxide (NaOH). |       |
|     |               | **Step II** | Mixing diazo salt, “air keras” solution (HCl/H2SO4) and sodium nitrite (NaNO2). Diazo/diazonium salt is a group of organic compounds made with three kinds of reagents, namely an aromatic amine primer, a mineral. |       |
The reaction of the diazonium salt is carried out in cold conditions by maintaining the reaction temperature below 5°C. The reactions and properties possessed by diazonium salt is much in common with quaternary ammonium salt, namely 1) The solution of diazonium salt obtained from strong mineral acid is neutral, and the results of the measurement of hantarya power show that the solution is dilute ionized perfectly. 2) If the solution of salt is benzenediazonium chloride reacted with silver hydroxide, silver chloride deposits (white) are produced, while the solution is a strong base.

| No. | The Questions | Indigenous Knowledge | Chemical Education Reconstruction |
|-----|----------------|----------------------|----------------------------------|
|     |                | Tools                | Ingredients                      | Waste                                          |
|     |                | 1. Hot type/"obat lanang" | the coloring is very strong, so cannot be removed. | Fosen dyes                                   |
|     |                | 2. Cool type/"obat wedok" | colors that have been extended can be replaced or removed by chlorine or hydrosulfite. | "Kaporit"CaClO₂/hidrosulfit (Na₂S₂O₄): type of substance to remove color. Mixed chemicals for fosen dyes is “soda kue” (NaHCO₃), “abu soda” (Na₂CO₃) or Na₂SO₄ (sodium sulfate), water glass liquid (Na₂SiO₃). |
| 4.  | How to make the batik? |                         |                                  | The process is carried out by inserting the canting into an “ender” container containing liquid wax (pressed), canting is lifted and then printed onto the surface of the cloth. By |
|     |                | 1. Tasting/"nglowong"  | thicken the pattern on the fabric by stamped using a canting dipped in |
ender containing liquid wax

2. Nyolet
Coloring process in certain parts using a brush.

3. Mopok
Covering or protecting colors from the others when coloring based color

attaching the canting to the surface of the fabric, the wax freezes again (changes in the shape of the object) and attaches to the fabric.

Coloring pattern using synthetic dyes was remasol what mixed cool water. Waterglass used for fixation process

Protection against the color of batik at the nyolot stage, using wax. Wax is the lipid class which has hydrophobic properties, which will protect the fabric from mixing other colors.

| No. | The Questions                                      | Indigenous Knowledge                                                                 | Chemical Education Reconstruction                                                                 |
|-----|----------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
|     |                                                    | Tools | Ingredients | Making Batik Process                                                                 | Waste                                                                                     |
| 4.  | Based Coloring                                     |       |             |                                                                                | Chemicals in dyes:                                                                          |
|     | There are two steps in based coloring: the first   |       |             |                                                                                | Custic: “soda api”, sodium hydroxide (NaOH). The function: as a fixation material              |
|     | coloring cannot produce any color separately and   |       |             |                                                                                | for reactive dyes related to the coloring the second coloring process.                     |
|     | the second coloring produce a dye.                 |       |             |                                                                                | The function of NaOH in industry for cooking cotton, rayon, and polyester fabrics, using     |
|     |                                                    |       |             |                                                                                | for mercerization on cotton fabrics etc. “Air keras”: HCl or H$_2$SO$_4$, a mixture of      |
|     |                                                    |       |             |                                                                                | materials to generate color in the step II coloring process. The “air keras” function is    |
|     |                                                    |       |             |                                                                                | saponification process in indigosol dyes.                                                  |
|     |                                                    |       |             |                                                                                | Na$_2$S$_2$O$_4$: Is a white crystalline powder that smells like sulfur. This compound acts    |
|     |                                                    |       |             |                                                                                | as a reducing agent, which is commonly applied to the dyeing or coloring process. If exposed |
|     |                                                    |       |             |                                                                                | to these compounds is the occurrence of                                                      |
irritation when exposed to the eye, swallowed, inhaled and direct contact with the skin. Physiologically sodium hydrosulfite is unstable. The easier it is to decay, the easier it is for acid formation. Na₂S₂O₄ readily decomposes in water and reacts with oxygen. The reactions that occur are oxidation reactions that produce HSO₃⁻, SO₃²⁻, and HSO₄⁻.

| No. | The Questions | Indigenous Knowledge | Chemical Education Reconstruction |
|-----|---------------|----------------------|----------------------------------|
|     |               | Tools                | Ingredients | Making Batik Process | Waste | NaHCO₃ | Is a white crystal, used as a buffer agent, replenisher electrolyte, systemic alkalizer and cleaning solution. The compound is a stable compound if it is in a dry environment, but decomposition will occur when in a humid air environment. When the compound is heated to a temperature of 50 °C, the substances that will be produced are like, smoke and carbon dioxide. | Na₂SO₄ | Sodium sulfate/sodium sulfate is a sodium salt of sulfuric acid, anhydrate sodium sulfate associates in water to produce sodium ions and sulfate ions. Sodium ions are the main cation of extracellular solutions and play an important role in electrolyte deficiency. Anhydrous sodium sulfate is also a filling material in isotonic solutions. |
| 5.  | Nglorod       | The process of dissolving the wax. | |

Step 1: dyeing cloth on boiling water, to shed wax attached to the cloth. The heating
The nglorod has two steps, namely step I dyeing of cloth in boiling water and step II mixing the boiling water and soda ash. The process uses temperatures reaching the wax melting point. Step II: mixing the boiling water and soda ash ($\text{Na}_2\text{CO}_3$) which is a white compound, easily dissolves in water and forms a strong alkaline solution. Known as washing soda because it is often used in washing clothes. In other hand, the purpose of the step is to protect the batik dyes so they aren't easily fade, speed up nglorod and smoothing the cloth.

| No. | The Questions |
|-----|---------------|
| 6.  | Washed        |
|     | Washing the cloth two times |
| 7.  | Laseman/Rentesan |
|     | used to combine of the pattern’s edge with the specks with the final result of the color gradation, namely white, white sogan, and sogan with cumi ‘i techniques. |
| 8.  | Nyogan        |
|     | Dying the fiber on sogan dyes. |
| 9.  | Nglorod       |
|     | This process same as on fifth process |
| 10. | Washing       |
|     | using water to remove chemical compounds that attach to the fabric |
| 11. | Drying        |
| No. | The Questions                                           | Tools | Ingredients | Making Batik Process | Waste                                                                 | Chemical Education Reconstruction                                      |
|-----|---------------------------------------------------------|-------|-------------|----------------------|----------------------------------------------------------------------|------------------------------------------------------------------------|
| 5.  | How do you handle the waste of batik making?           |       |             |                      | Batik waste is just thrown away. Chemical compounds in the waste are not treated first and flow, blend around the neighborhood. Color waste in the hands of the sewerage. Color cleaning agent is cleaned using chlorine / waste attached to calcium hypochlorite (CaClO₂), a toxic chemical compound, can irritate the skin. removed using CaClO₂ is commonly used for water purification, disinfecting in swimming pools, bleaching on paper and textiles. |                                                                       |
6. Conclusions
This research has reconstructed the indigenous knowledge of Batik Pekalongan as chemical awareness that can be used for teaching and learning resource. Based on the results of the study, it can be concluded that in the process of making Pekalongan Batik there is an indigenous knowledge that can be reconstructed and interpreted into scientific awareness so it can be used as a learning resource in chemical education.

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