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Concept Analysis of Heat and Temperature in *Gedog Batik*

Vika Luthfiyatun Ni'mah [1], Nanda Sofa Imamah [1], Rinda Rahmanisa Sasmi [1], Krisna Muftidafila Ilham Rosyida [1], Alfi Nurlailiyah [2], and Suliyanah [1,*]

[1] Physics Education, Universitas Negeri Surabaya, Surabaya, Indonesia
[2] SMA Negeri 1 Waru, Sidoarjo, Indonesia
[*] Email: suliyanah@unesa.ac.id

Abstract

Batik Gedog, a traditional craft from Tuban Regency, is rich in local wisdom, particularly in its unique manufacturing processes, motifs, and colors. This study aims to analyze the concepts of heat and temperature involved in creating Batik Gedog, demonstrating its potential as a contextual learning medium for teaching these concepts. The research adopts a qualitative descriptive approach, utilizing ethnographic methods to gather insights. Purposive sampling was employed to select Batik Gedog craftsmen with comprehensive knowledge of the Batik-making process. Data collection involved interviews with two craftsmen from Kerek District, Tuban Regency, and a review of relevant literature. The data were analyzed using the Miles and Huberman model. The findings reveal the presence of heat transfer mechanisms—conduction, convection, and radiation—during the Batik-making process, alongside the phase change of Batik wax from solid to liquid through heating. These results underscore the relevance of heat and temperature concepts in the traditional practice of making Batik Gedog.

Keywords: Local Wisdom, *Gedog Batik*, Heat and Temperature

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INTRODUCTION

Education is the main foundation for all individuals who can provide change and develop the country in a more advanced direction. Education has a vital role for humans because it can shape the intellect and skills and have the civilization values needed for future life. Education has an impact that can be seen and felt directly by providing stimulus to cognitive, affective, and psychomotor abilities (Uran et al., 2024). Education can also be interpreted as a pillar for each individual to become a quality next generation to face and solve problems in community life that differ in each region. Education can be obtained from schools, which are places to get lessons both in material and implementation in everyday life. It can be seen that education in schools has several subjects that are following the curriculum.

The Indonesian education curriculum has transformed from the K-13 curriculum to the *Merdeka* curriculum. The *Merdeka* curriculum provides freedom and makes it easier for teachers to learn activities by adjusting the needs of students. The implementation of the *Merdeka* curriculum focuses on the character of students. Changes to the education curriculum in Indonesia aim to achieve more effective and efficient education by forming individuals who are religious, moral, knowledgeable, and have physical and spiritual skills, as well as a sense of responsibility. Freedom in the *Merdeka* curriculum can be implemented in physics subjects.

Physics lessons can improve students' critical and analytical thinking skills, which is one of the implementations of the *Merdeka* curriculum. Students consider physics learning a threat, so they need help

understanding the lesson well. Students think that physics lessons are identical to calculation formulas, which results in students only fulfilling the obligation to take physics lessons (Uran et al., 2024). One strategy for improving student characteristics is through ethnoscience.

Ethnoscience is knowledge possessed by a particular tribe or social group (Wae & Kaleka, 2022). In education, ethnoscience is an important aspect where students' ability to understand and relate scientific concepts to local culture needs to be emphasized. Ethnoscience is an intermediary between indigenous scientific knowledge and local wisdom, a learning of natural culture that has developed in community life (Pangga et al., 2023).

Based on etymology, wisdom is the ability possessed by a person to respond to an event, object, or situation using their mind. Meanwhile, the word local describes the context of space and time of the interaction of an event or situation. In this case, local wisdom can be interpreted as the potential of resources found in the community or a region. It is believed to be accurate and is used as a guideline for taking action and behaving (Sholahuddin & Admoko, 2021). Local wisdom is knowledge that comes from the thoughts of a group of people related to the culture and lifestyle of the community. The culture and lifestyle of the local community are related to economic, social, and environmental aspects (Taib et al., 2021). Local wisdom includes traditional knowledge, cultural values, customs, and various forms of knowledge passed down from generation to generation (Erman & Suyatno, 2022). Therefore, local wisdom can be interpreted as the potential of resources related to traditional knowledge, cultural values, customs, and other forms of knowledge passed down from generation to generation.

Batik has a local wisdom value in its arts and crafts and reflects a rich cultural heritage with deep meaning. Making *Batik* contains symbolic meaning in every motif, color, and technique. Every process of making *Batik* has a symbolic meaning that has the philosophy of the local community. *Batik* reflects identity, loyalty, and high-level skills passed down from generation to generation (Syahza et al., 2020). The value of local wisdom in *Batik* can enrich the understanding of history, local wisdom, and cultural sustainability (Varghese & Crawford, 2021). Therefore, it can be interpreted that hand-drawn *Batik* does not only have added value in its visual beauty.

Batik is closely related to the concept of physics, for example, during the manufacturing or production process (Nikmah et al., 2023). Generally, the *Batik*-making process is carried out by making a pattern of layering patterns with wax, coloring, and wax refining. The *Batik*-making process uses a canting containing liquid wax to draw motifs on the cloth. Each motif has a different symbolic meaning in each region due to various factors, such as community customs, strong traditions, and abundant resource potential (Trixie, 2020). One type of *Batik* that has developed in Indonesia is *Gedog Batik*.

Gedog Batik is an example of a noble cultural heritage originating from Kerek District, Tuban Regency. One of the unique features of *Gedog Batik* is that it is influenced by the acculturation of three cultures, namely Javanese, Islamic, and Chinese (Sari et al., 2022). In addition, other characteristics of *Gedog Batik* lie in the manufacturing process, motifs, and colors. Each stage of the *Batik*-making process has its philosophy and is closely related to understanding the concept of physics. Previous research on the local wisdom of *Batik* integrated into science covers various aspects. There are physics concepts applied in making *Batik* Sendang Duwur, especially in the material of temperature and heat (Nikmah et al., 2023). The process of making *Batik* has a close relationship with various fields of ethnoscience, one of which is ethnophysics, namely the change in the state of wax from solid to liquid (Anissa& Silfianah, 2023). The motifs found in *Gedog Batik* can be studied using an ethnomathematics approach (Wati et al., 2021). *Batik* teaches character values such as hard work and perseverance. Through ethnoscience learning, especially in *Batik* coloring, these character values can be instilled in the younger generation as part of *Indonesia Emas* 2045.

Development of a physics module based on local wisdom on the material of temperature and heat that makes it easier for students to learn physics (Agustin, 2018). A physics module integrated with local wisdom in making Jambi *Batik* is needed to improve students' creative thinking skills (Putra et al., 2023). In addition, there is research on processing printed *Batik* waste using chemical techniques (Murniati & Muljadi, 2013). The *Batik*-making process, which includes pattern making, covering the pattern with wax, coloring, and removing the wax, shows different levels of fineness of the motifs in each *Batik* (Setiawan et al., 2018). In addition, Android-assisted physics learning with *Batik* local wisdom can improve high school students' creative thinking and problem-solving skills (Shabrina & Kuswanto, 2013). The integration of *Gedog Batik* into physics learning is a form of ethnophysics. Through this ethnophysics-based learning process, students are expected to be able to understand physics concepts better and participate in efforts to preserve the nation's culture (Laila et al., 2021). This research study an in-depth exploration of the manufacturing process and the concept of

temperature and heat material in *Gedog Batik*, which has yet to be identified in previous studies. Therefore, this study aims to identify the process of making *Gedog Batik* from Kerek District, Tuban Regency, and to identify *Gedog Batik* as a contextual media based on local knowledge for physics learning, especially temperature and heat material. The concepts of temperature and heat are deeply explored and integrated into physics learning in the *Merdeka* Curriculum. This finding is expected to support the achievement of effective learning as the goal of the *Merdeka* Curriculum and maximize efforts to preserve local Indonesian culture.

METHOD

This research is a type of qualitative descriptive research using an ethnographic approach. An ethnographic approach deeply describes and analyzes culture in intensive field research (Setyowati, 2006). This study uses an ethnographic approach to describe, explain, and analyze physics concepts (Rumiati et al., 2021). The sampling technique in this study is purposive sampling, which is a sampling determination technique with certain considerations (Sugiyono, 2012). The location of the research is Kerek District, Tuban Regency. The criteria for selecting this sample is someone who knows how to make *Gedog Batik*. So, the subject in this study consisted of 2 *Gedog Batik* craftsmen.

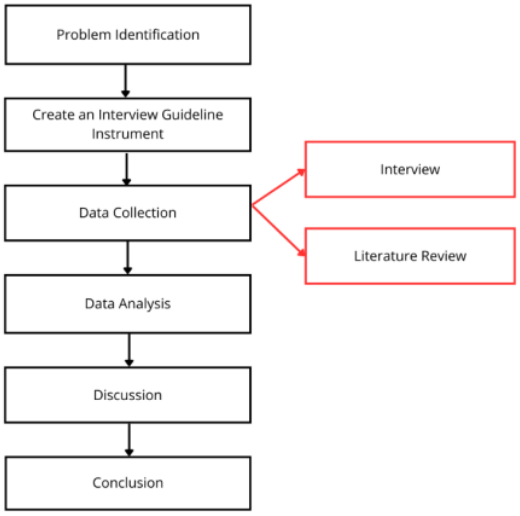

Figure 1. Research Design

The research flow diagram can be seen in Figure 1. Data collection methods are interviews and literature studies. Interviews are a way to obtain information from reporters directly through face-to-face meetings (Lestari et la., 2022). Therefore, interviews with *Batik* craftsmen were conducted to obtain information directly using interview guidelines. A literature study on the *Batik*-making process was also conducted through relevant sources. Data analysis techniques consist of three simultaneous activity, namely: (1) data reduction, (2) data presentation, and (3) conclusion or verification (Miles & Michael, 1992). In this study, data will be selected from interviews and literature studies. Furthermore, the data will be presented in the form of descriptive text. The last stage in the research is making a conclusion.

RESULTS AND DISCUSSION

Based on the interview results with *Gedog Batik* craftsmen, *Gedog Batik* is a type of local coastal *Batik* wisdom originating from Kerek District, Tuban Regency. In the process of making *Gedog Batik*, the sound '*dog-dog-dog*' is heard, which is the origin of the name *Gedog Batik*. The sound '*dog-dog-dog*' comes from the tool used to weave thread into cloth. Initially, *Gedog Batik* was brought by an Admiral from China during the Majapahit era, namely, Admiral Cheng Ho. Then, *Gedog Batik* was adopted by Ki Jontro, who was a follower of Ronggolawe. At that time, Ronggolawe and his followers rebelled against the Majapahit Kingdom, which caused them to hide in the forest. While they were hiding, the name Jontro was used as the name of the traditional loom used to make clothes for his troops. Initially, the motif of the stripes on the troops' clothes was

by the thread flow of the woven cloth. Over time, the motif of the clothes changed due to the influence of Lokcan *Batik* from Admiral Cheng Ho. After that, the woven fabric was made into a *Batik* known as *Gedog Batik* to this day.

In ancient times, people used woven fabric or *Gedog Batik* as a long scarf (*sayut*) and *jarit*. People used *sayut* as clothing to identify groups and social status of women, from virgins, married women, to elderly women. Meanwhile, *jarit* was used by the community as a sign of where they came from, such as someone who came from the north, south, east, or west of the Kerek market.

Gedog Batik is one of the superior products of local wisdom passed down from generation to generation. Initially, *Gedog Batik* was only made into clothing for local people. Over time, *Gedog Batik* was produced as a souvenir from the Tuban Regency. The center of *Gedog Batik* production is in Margorejo village because many craftsmen in the home industry produce *Gedog Batik* in the area. Many local women work as *Gedog Batik* craftsmen because they have mastered the techniques of weaving and *Batik* making since elementary school. The *Gedog Batik* industry has a promising opportunity for the local community to improve the economy. Usually, *Gedog Batik* craftsmen leave their goods in tourist areas in the Tuban Regency.

Gedog Batik has several characteristics that are different from other *Batik*, such as the color of the woven fabric used and the *Gedog Batik* motifs that display flora and fauna (Amir, 2017). The fabric used in *Gedog Batik* is a white or brownish-white woven fabric, which the people of Kerek District themselves make the fabric. This makes *Gedog Batik* have its characteristics because it has a material texture from traditionally woven threads. The symbols found in *Gedog Batik* also have meanings that show the attitudes and behavior of the community. In addition, *Gedog Batik* has a variety of motifs, around 100 motifs. However, the Tuban Regency government in 1987, with the Regulation of the Minister of Justice of the Republic of Indonesia Number M.01-HC.03.01 of 1987, only registered 40 motifs (Kartikasari & Sarmini, 2017).

Some examples of *Gedog Batik* motifs patented by the government include the *Selimun*, *Kijing Miring*, *Panji Serong*, *Gringsing*, *Kembang Waluh*, *Selimun*, *Manuk Jalak*, *Panji Krentil*, *Ganggeng*, *Uler Keket* motifs, and many more (Qomariyah, 2017). Each motif found in *Gedog Batik* has a different meaning based on the social strata of society. Some motifs are specifically for the palace community and ordinary people. The *panji-panjian* motif is specifically for the nobility, while ordinary people use the Kijing Miring, Ganggeng, Bang Tegeran, and Gringsing motifs (Nurdiantika & Widodo, 2015).

The equipment needed to make *Gedog Batik* is *canting*, frying pan, *pagaran*, and chair. Then, the materials needed, namely cloth, wax, and dye. There are several stages in making *Gedog Batik*. The first stage is making cloth that makes *Gedog Batik* unique. Making *Gedog* cloth or *Gedog* woven cloth is processed using a traditional loom that is done by hand. The process of making cloth also goes through several stages, namely *mengantih*, which is commonly called spinning yarn. In this *mengantih* stage, it includes the activity of grinding cotton, *musoni* or unraveling cotton that has been milled, then changing so that it produces yarn that has been spun. The last stage of making *Gedog* cloth is weaving where there are several stages for the weaving process including preparing the warp thread, preparing the weft thread, and weaving activities. The warp thread is the activity of moving the thread from the grid to the loom while arranging the thread in the form of a roll with a certain size. The thread that has been rolled into 5 strands of thread is also called *lawe sekawan* thread, while *tukelan* is a roll of *sekawan* thread. *Lawe* yarn that is still white is not ready to be woven because the condition of the yarn is still limp or not solid, which causes the yarn to break easily. The material used to stiffen the *lawe* yarn is only rice that has been crushed with water or called *nyekuli*. Threads that are already stiff can be dyed if you want to weave with more than one color (Siwi & Hidayat, 2019).

Coloring can be done in two ways: by *wedel* or indigo and using artificial dyes such as naphthol. From these stages, warp and weft threads are obtained, which are attached to the loom. The weaving process is like weaving, usually using traditional tools, so the yarn that has been made produces *Gedog* cloth, which has a characteristic rougher texture compared to cloth produced in factories. The process of making *Gedog Batik* in general is not much different from the process of making other *Batik*. There are several stages to create this unique *Gedog Batik*. These stages include the *ngentel*, *lengreng*, *nerusi*, *nembok*, *nyelup*, *mopok medel*, *nglorot*, and *nyuci*. The *ngetel* stage is the soaking the cloth to be *Batik* using clean water for two days. The soaking reduces the remaining thread hardener used during the weaving process. The *lengreng* stage uses a canting to make a pattern or motif frame on the cloth. In this process, heating is also carried out on the night/wax with ambient temperature. When heating the night/wax, a stable temperature must be used, which should not be cold or too hot. The heating of the night/wax is so that it sticks to the cloth well.

Figure 2 *Nerusi* Stage (Coloring) (Agnes, 2021)

Next step continues to the *nerusi* stage, where this stage is *Batik* on the other side with the same motif as the previous one. An illustration of this process is shown in Figure 2. After the *nerusi* stage is finished, the *nembok* stage is continued. The *nembok* stage uses a canting to cover the inside of the motif pattern made at the *lengreng* stage with a specific color to avoid the dyeing process later.

Figure 3. *Nyelup* Stage (Coloring) (Agnes, 2021)

The *nyelup* stage is the first coloring stage to get a specific color other than white and dark blue. An illustration of this process is shown in Figure 3. However, for coloring on specific motifs or arrangements to avoid certain parts of the dyeing process is the *mopok* stage. The *mopok* stage is carried out to determine which parts of the motif are left open so that they are exposed to color during the *nyelup* process and which parts must be covered to avoid the immersion and continued to the *medel* stage which is the final stage in the coloring process. *Medel* or *wedelan* is coloring using indigo from certain plants or tom leaves (Tarum) to give a blue color. Then, the *nglorot* stage is melting the remaining wax on the cloth by boiling it in boiling water. The heat of the boiling water makes the wax melt and come off the *Batik* cloth. The final stage of making *Gedog Batik* is the washing stage. An illustration of this process is shown in Figure 4.

Figure 4. Washing Stage (Washing *Batik*) (Agnes, 2021)

The washing stage aims to remove the remaining coloring on the *Batik* cloth that has not been absorbed into the *lawe* thread. The drying process is carried out by drying in the sun. Making *Gedog Batik* is quite long, taking approximately three months because the process must go through a long process from spinning the thread to the last stage, namely washing. There is a unique process in making *Gedog Batik*; namely, before making *Gedog Batik*, the cloth must be made first. From making the cloth, there is a difference in the texture of the cloth, which is rougher compared to other *Batik* cloths, which makes a particular part of *Gedog Batik*. The constraints of making *Gedog Batik* depend on the season. The craftsmen need the bright or hot season

because of the lighting needed to carry out the *Batik* process and during drying. Drying is not directly exposed to sunlight, but the drying process will take longer if there is no sunlight.

Currently, *Gedog Batik* is very rare because some craftsmen no longer produce this *Batik*. This fact is because weaving thread takes a long time, so it is rare for craftsmen to weave their thread. There are also quite a few craftsmen who only produce *Batik* woven cloth if there is an order. Even though this condition occurs, the *Gedog Batik* production process is still widely carried out using *mori* cloth (Maulida & Agustin, 2020). In addition, some craftsmen prefer to produce *Gedog Batik* with development motifs to increase sales and raise the local wisdom of *Gedog Batik*. On the other hand, this development can be a threat to the preservation of traditional *Batik* motifs. Historical records and documentation of the *Gedog Batik*-making process are also starting to be rarely found so it can cause the next generation to have difficulty in learning and maintaining the existence of the original *Gedog Batik* (Sari et al., 2022).

During the *Batik* process, the craftsmen heat the wax (*Batik* wax) on the stove to melt it. In terms of physics, this process occurs because the stove conducts heat to the pan, making the pan hot. The heat from the pan is then transferred to the wax, causing the wax to melt. This process shows how heat can move from one object to another. Boiling *Batik* cloth, known as the nglorot process, removes the wax that sticks to the *Batik* cloth. In this process, the cloth is boiled in boiling water so the wax melts again. As seen in Figure 5, *Batik* craftsmen use wood to move the *Batik* cloth from the pan so that it is not exposed to direct heat (Agnes, 2021).

Figure 5. *Nglorot* Process (Boiling *Batik* Cloth) (Agnes, 2021)

Even so, craftsmen will still feel the heat from the stove even though they do not touch it directly. This phenomenon happens because heat can be transferred in three ways. The following are three methods of heat transfer that occur in the process of making *Gedog Batik*.

Conduction

Conduction is transferring heat from one object to another through a medium. During heat transfer by conduction, the substance or atoms of its constituent molecules do not move. Heat transfer by conduction due to the movement of electrons only occurs in metal materials containing free electrons. An illustration of this process is shown in Figure 6. This process occurs at the *lengreng*, *nerusi*, *nembok*, and *nglorot Batik* stages. Heat transfer occurs in the pan used to melt the wax, the canting, and the pan used to boil water.

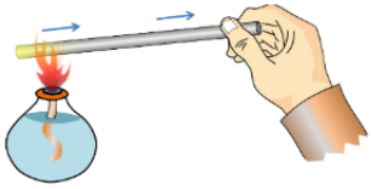

Figure 6. Conduction Illustration (Shadri, 2024)

Heat transfer by conduction due to atomic vibrations can occur in all solid objects. However, heat transfer through the movement of electrons is much more efficient than atomic vibrations. Therefore, conduction in metals occurs much more quickly than in non-metallic materials. In insulators, conduction also occurs (due to the oscillation of moving atoms) but is very slow, so the material is said to be a barrier to heat flow. If one end of the glass is heated, the other will heat up after a long time. This fact is the evidence of conduction in non-metals. Examples of insulating materials are wood, plastic, and rubber. The handle of the *canting*, which is

used to apply wax to cloth, is made of wood so that the craftsman's hands do not feel hot when making *Batik*. An illustration of this process is shown in Figure 7.

Figure 7. The Useage of Canting (Agnes, 2021)

Convection

Convection is the transfer of heat spread by the movement of molecules in an object. Figure 8 illustrate the convection process of a water in a kettle. When a part of an object receives heat, its constituent atoms move faster. As a result, the atoms are pushed to a place where they are still oscillating slowly. This transition of fast-moving atoms carries heat energy so that heat moves from areas of high temperature to areas of low temperature.

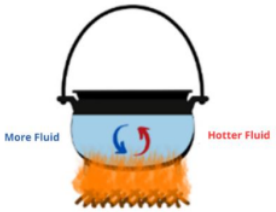

Figure 8. Illustration of Convection (Utami, 2024)

Heat transfer by convection occurs at the *Batik lengreng* and *nglorot* stages. At this stage, heat transfer occurs when the wax (*Batik* wax) is heated until it melts, and the water is heated until it boils. Convection only occurs in objects whose molecules can move freely, such as liquids and gases. Therefore, convection occurs in liquids or gases. When water in a pan is heated, the part that receives heat is the part in contact with the pan, namely the bottom. Over time, the entire water becomes hot because water molecules flow from bottom to top. This flow pushes cold and hot water down until all the water becomes warm.

Radiation

Radiation is the transfer of heat without going through a medium. An example of heat transfer through radiation is the sun's heat that we feel on Earth, even though the space between the sun and the Earth is a vacuum. Air is a poor conductor of heat. When lighting a campfire, we can feel the heat even though we are about half a meter from the fire. The final process of making *Batik*, drying process, is shown in Figure 9.

Figure 9. *Batik* Cloth Drying Process (Subekti et al., 2020)

Radiation occurs during the *Batik* making stage, especially when drying *Batik* cloth in the sun. The process of heating the cloth with sunlight occurs without any media as an intermediary. In addition, we can also feel the heat of radiation when we are near the fire at other stages, such as when *nglorot*, *nembok*, and other processes involving fire. Our bodies feel the heat despite not touching the heat source.

CONCLUSION

Gedog Batik is a local wisdom originating from Tuban Regency with unique characteristics in the manufacturing process, motifs, and colors. The process of making *Gedog* hand-drawn *Batik* begins with making cloth by weaving. After going through several processes of making cloth, the cloth is ready to be *Batik*ed. The process of making *Batik* goes through several stages, namely: *ngentel*, *lengreng*, *nerusi*, *nembok*, *nyelup*, *mopok*, *medel*, *nglorot*, and *nyuci*. Based on the analysis, the concepts of temperature and heat were found when making *Gedog* hand-drawn *Batik*. Conduction heat transfer occurs in the *lengreng*, *nerusi*, *nembok*, *nyelup*, *medel*, and *nglorot* processes. Furthermore, conduction heat transfer occurs in the pan used to melt the wax (*Batik* wax), *canting*, and drum or pan used to boil the dye. Heat transfer by convection is also performed at that stage. Heat transfer occurs in the wax (*Batik* wax), which is heated until it melts, and in the dye that has been mixed with water until it boils. Heat transfer occurs during the drying process by radiation when the *Batik* cloth is dried in the sun. In addition to the heat transfer process, there is also a change in form in the *Batik*-making process. The change in form occurs in the wax, which was originally solid and then melted after heating. Further research is expected to be able to examine the *Batik* making process in more depth from a physics perspective, both in the entire process and with a focus on a particular stage, and the application in the learning Physics.

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