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Ethnophysical Study of Temperature and Heat in The Canting Process of Making Written Batik

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Abstract

Batik tulis is identical to the *canting* process, which involves applying hot wax using a *canting* to the cloth. In this process, there is a physical concept of temperature and heat, both on the wax and on the *canting*. Because of this, the purpose of this study is to conduct an ethnophysical study, namely the concept of temperature and heat in the *batik tulis canting* process. This study uses a qualitative method with observation and literature studies. The results obtained indicate that the form of the wax changes due to the influence of temperature, which is a physical change. The temperature at night affects the viscosity of the wax, which in turn affects the smoothness of the wax as it passes through the *canting* tip. Additionally, there is heat transfer and expansion in the *nyamplung* and at the tip. The implications of the research can be applied both theoretically and practically. Theoretically, it can be applied in learning that proves several physics theories, such as the concept of expansion and changes in form due to heating. In practice, this is directly beneficial for batik craftsmen, as they can choose to use either used wax or new wax in the batik process to produce a profitable economic value.

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INTRODUCTION

Batik is one of the creative economic crafts that is experiencing rapid growth. In addition, batik is also included in one of the nation's cultural heritages, so it needs to be preserved (Rosyada & Tamamudin, 2020). UNESCO has designated batik as a humanitarian heritage for oral and intangible culture from Indonesia in 2009 (Asiatun & Islami, 2020; Laksmi, 2011). According to the manufacturing process, there are three types of batik, namely hand-drawn batik, stamped batik, and printed batik (Nurainun et al., 2008).

Each region has its uniqueness for batik tulis. This uniqueness can be in the form of motifs or other characteristics (Hidayat & Ulfa, 2023; Larasati et al., 2021; Maghfiroh, 2020). Batik *tulis* is a textile craft that is made with hot wax and canting *tulis* (Mandegani et al., 2018). Batik *tulis* is identical to the manual canting process. A canting is a tool used to etch or apply hot wax to fabric (Nurcahyati et al., 2017; Prasaja & Jani, 2020). There are

various types of *canting*, depending on their use. The types of *canting* are as shown in Figure 1.

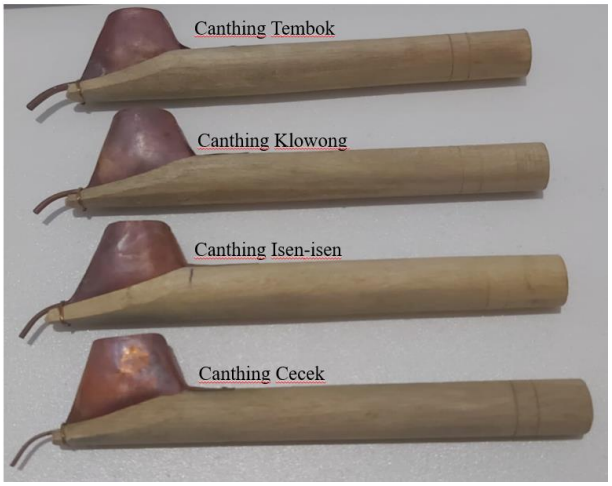

Figure 1 Different types of canting

A canting consists of a handle, a container or place for the wax liquid or *nyamplung*, and a tip for the wax to come out (Laksmi, 2011). In Figure 1, several types of canting are illustrated. The wall or *nembok* canting is used to create blocks on the fabric. The *klowong* or *rengrengan* canting is used to make main lines. The isen-isen *canting* is used to create scratches in the main motif, and the *cecek* canting is used to create dot motifs. Some also say that isen-isen is also used to make dots *(cecek* canting*)*. Canting is distinguished by its diameter, function, and the number of tips. (Laksmi, 2011).

Wax that has been heated and melts at approximately a temperature of 67 °C- 72 °C. Then it is placed on the *nyamplung* and passed through the tip to inscribe it onto the fabric. In this process, physical concepts related to temperature and heat are involved. There are changes in form at night, heat transfer, and so on.

Due to the above, the purpose of this study is to examine the concept of physics, especially temperature and heat, in the canting process. This study is likely to contribute to the preservation of culture, particularly batik, through the transmission of cultural knowledge (Nahak, 2019), thereby enhancing batik's status as a national cultural icon in the educational sphere.

In addition, research has been conducted on the commercial potential of hand-drawn batik in Malaysia (Pegah, 2017). The process of making batik, which includes creating patterns, coating the patterns with wax, coloring, and removing the wax, reveals different levels of fineness in the motifs of each batik (Azha et al., 2021; Syed et al., 2021). The integration of the canting process in batik making into physics learning is a form of ethnophysics. Through this ethnophysics-based learning process, it is hoped that students will gain a deeper understanding of physics concepts and participate in efforts to preserve the nation's culture (Adam et al., 2024; Souisa et al., 2024; Batlolona et al., 2022).

This study is an in-depth exploration of the manufacturing process and the concept of temperature and heat materials in hand-drawn batik, which have not been previously identified. Therefore, this study aims to identify and examine the process of creating hand-drawn batik as a contextual medium based on local wisdom for physics learning, particularly in relation to temperature and heat materials. The concept of temperature and heat is explored in depth and integrated into physics learning. These findings are expected to support the achievement of effective learning and maximize efforts to preserve local Indonesian culture. Additionally, it serves as a reference for batik craftsmen to maximize

the use of wax, both old and new.

METHODS

This research is part of a qualitative study that analyzes and discusses one of the nation's cultures, which has been passed down from generation to generation, specifically in the form of batik *tulis*. The study focused on the concept of temperature and heat in the *canting* process, one of the fundamental processes in *batik tulis* production. Data were collected, analyzed, and presented in the results and discussions so that a conclusion was obtained (Astuti et al., 2021). Data collection was carried out by direct observation and literature study. Literature studies in the form of articles in journals, proceedings, and documents relevant to the focus of the study.

Fluid analysis on canting is conducted through a literature study, which considers key fluid concepts, including dynamic fluid, the continuity principle, and Torricelli's principle, an application of Bernoulli's Law. The measurement data in the form of heat flow parameters and heat flow rates are then analyzed using Microsoft Office Excel to determine the difference between wax samples when melted and frozen.

RESULTS AND DISCUSSION

In the canting process, the wax is first heated using a stove until it melts and liquefies, at approximately 67 °C - 72 °C (Bapat, 2013; Ghosh, 2023; Sharifah et al., 2017). Then the wax is scooped up with the part of the wax container, *nyamplung*. The hot wax that has melted will flow through the canting tip. The larger the diameter of the tip, the faster the flow will be, and vice versa (Adeyanju, 2016; Sulistiani et al., 2022).

$$Q = A.v \quad (1)$$

Where Q is the flowing discharge ($^{m^3}/_{s}$), A is the cross-sectional area of the pipe (m^2), and ν is the flow rate ($^{m}/_{s}$).

The diameter of the rengreng canthing tip is around 1–2.5 mm, and the isen-isen canthing tip is around 0.5–1.5 mm. Yuliati (2010) explained that there are also cantings pokpokan with a diameter of 2.5 – 3.5 mm and canting *dodosan*, which have a diameter of 3.5 mm. Canting *pokpokan* is used to cover areas of the motif, and canting *dodosan* is used to cover the background between areas of the motif that are loose (Laksmi, 2011). Apart from that, the prongs on cantings have many variants, including cantings with one prong, two prongs, three prongs, and so on.

The *nyamplung* and *cucuk* on the canthing are made of brass or copper plates (Laksmi, 2011; Prasaja & Jani, 2020). So, when exposed to hot liquid wax, it can conduct heat. Heat is a form of energy that can move from high temperatures to low temperatures. Heat transfer in *nyamplung* and *cucuk* occurs by conduction, which is a form of heat transfer that does not involve the movement of particles of the conducting substance. Heat transfer by conduction can occur through collisions between particles or free electrons. The speed of heat flow per unit time is called the heat rate (H), or written:

$$H = \frac{\Delta Q}{\Delta t} \quad (2)$$

The rate of conduction heat can be calculated using the equation (Rokhimi & Pujayanto, 2015):

$$H = \frac{k.A.\Delta T}{\ell} \quad (3)$$

k is the thermal conductivity; for copper, the value is 385 $^{W}/_{mK}$, A is the surface area (m^2), ℓ is the length of the object (m), and ΔT is the temperature change (^oC).

Every object has a heat capacity, which is the ability of an object to absorb or release heat to increase its temperature by 1 °C. Heat capacity (C) can be calculated by:

$$C = \frac{Q}{\Delta T} \quad (4)$$

Or it can also be calculated by,

$$C = m.c \quad (5)$$

Where m is the mass of the substance (g or kg), and c is the specific heat (J/^{o}C or cal/^{o}C).

While the handle on the canting is generally made of wood or bamboo (Affanti et al., 2018; Laksmi, 2011). The handle is a poor conductor of heat. The heat is contained in the *nyamplung* due to the wax liquid until the tip of the handle, where there is a decrease in temperature to 32°C with an error of around 3-6%.

Nyamplung and *cucuk* can also experience expansion due to the hot liquid of the wax. The increase in length can be written (Abdullah, 2016):

$$\Delta \ell = \alpha . \ell_o . \Delta \mathrm{T} \quad (6)$$

If an object is in the form of an area, then the change in area is:

$$\Delta A = \beta . A_o . \Delta T \quad (7)$$

Also, if the object is three-dimensional, the volume change is:

$$\Delta V = \gamma . V_o . \Delta T \quad (8)$$

With $\Delta \ell$ is the change in length, α is the coefficient of linear expansion, ℓ_o as the initial length, ΔA as the change in area, β as the coefficient of area expansion, and A_o as the initial area, ΔV as the change in volume, γ as the coefficient of volume expansion, and V_o as the initial volume.

Physical changes occur due to changes in form, without the production of new substances (Syroeshkin et al., 2018). In this case, changes in form occur at night due to the influence of temperature, as in Table 1. These changes occur when:

1) The waxing process begins. The wax, which was initially solid and hard, is heated until it melts and liquefies. When the wax feels too hot, the stove flame is turned off or reduced. At this time, the temperature decreases, causing the wax to thicken again. If the stove is turned off and not turned back on, the wax will freeze or harden again, as in Figure 2.

Table 1 Physical changes that occur in wax

No	Change	Remark
1	Melt	The wax is heated so that the form changes from solid to liquid.
2	Freeze	After the wax is heated, its temperature will gradually decrease. This causes the wax to thicken and freeze.

Figure 2 The wax freezes following the shape of the pan.

In the *cantingan* process, if the wax is too hot, the stove will be reduced or turned off. This prevents the wax from reaching its boiling point and undergoing a physical change into a gas or vapor phase.

2) When applying hot wax to the fabric with a canting. If the wax applied is not too liquid, it will affect the canting process. Wax that is too thick will inhibit the flow of the

wax, even causing the *canting* tip to become clogged, so that it needs to be heated. This is related to the viscosity of the wax.

CONCLUSION

Batik tulis is identical to the canting process, which involves applying hot wax to the fabric using a canting. In this process, there is a physics concept related to temperature and heat, both in the wax and in the *c*ontainer. The concept of the material includes physical changes in the wax, namely changes in form caused by changes in temperature. The temperature of the wax will affect the form or viscosity of the wax, which, of course, will also affect whether the wax is smooth or not when applied to the fabric using a canting. In addition, in the *nyamplung* and *cucuk* canting materials, heat transfer occurs due to the heat of the liquid wax. Expansion is also possible, although the value is very small. Further experimental research is needed to examine further the temperature and heat in various types of *canting*. The implications of this research can be applied to physics learning that integrates the local wisdom of the canting process, thereby improving students' creative thinking skills.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization, NNM and IYO; methodology, NNM, IYO, and QM; formal analysis, FW writing preparation of the original draft, All.

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