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STEAM Study on Local Wisdom of Batik Tulis Yogyakarta to Develop Science Teaching Materials

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Abstract: Batik tulis is one of Indonesia's cultural heritage which is rich in meaning and philosophical value. Batik tulis crafts are scattered in various parts of the region with their respective characteristics. One of the regions producing batik art is Yogyakarta. The process of making batik is often taught in arts and culture subjects in the context of preserving Indonesian culture, even though the process of making batik can also be integrated into science learning. There are many components in the process of making batik tulis related to natural science material. This research aims to determine aspects of STEAM (Science, Technology, Engineering, Art, and Mathematics) in the process of making batik for the development of junior high school science teaching materials. This research method uses qualitative research with descriptive analysis of the Miles and Huberman model. The sampling technique in this study was purposive sampling which was collected through observation, in-depth interviews, documentation, and literature review. The results of this study indicate that the local wisdom of batik tulis Yogyakarta contains STEAM aspects in the manufacturing process and can be used as science learning material in junior high schools.

Keywords: STEAM; Local Wisdom; Batik tulis Yogyakarta; Science Learning

Introduction

The uniqueness of Indonesia's culture and nature is scattered in various regions as a potential area that can be developed in developing the region. Of course, each region has a unique region, local knowledge, and culture. In the perspective of national education, the diversity of regional potentials is part of the consideration in planning educational policies and students should be able to learn through the surrounding environment, for example, such as local wisdom found in their respective regions (Khaerani et al., 2020; Khoiri et al., 2018; Wilujeng et al., 2017).

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 (Anugrah, 2021; Suryanti et al., 2021). This diversity can be a learning source and knowledge for students. Each tribe has its own characteristics of local wisdom in the form of perspectives on life, knowledge, and life strategies related to solving problems and fulfilling daily needs (Ilhami et al., 2019; Jufrida et al., 2019). The national education system requires the formulation of a curriculum based on local excellence or local wisdom, as stated in article 36 of Law no. 20 of 2003 concerning the National Education System. However, nowadays many young people are not aware of the local wisdom of their area. Some of them are more likely to choose to look for work outside their area. This is a problem for the world of education in Indonesia, where science education is still not integrated with the surrounding environment so that they tend not to be able to recognize their local wisdom.

Batik tulis is one of the oldest Indonesian art products. Batik tulis initially served as clothing material, whether in the form of scarves, head coverings, long cloth as sarongs, and even now it still functions as clothing material (Mulyani & Natalliasari, 2020; Naimah, 2013; Siregar et al., 2020). Batik along with batik

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making technique is one of many priceless Indonesian heritages which is originally coming from Java. Batik and its creative making process has been studied by many people around the world in various institutions (Atrinawati, 2022). Batik is a culture passed down by our ancestors with high artistic value and it cannot be denied that batik is the identity of the Indonesian nation. On September 28, 2009 UNESCO stated that batik is one of Indonesia's original cultural heritage. Since October 2, 2009 the United Nations Education Scientific and Culture Organization (UNESCO) has determined that batik is one of the world cultural heritages produced by the Indonesian people (Adishakti, 2009; Prasetyo & Singgih, 2016).

Batik business can develop well if there is support from various parties, such as family members, the surrounding community, and the government (Hastuti et al., 2023). Government support in the form of exhibitions and events will increase product marketing and encourage the emergence of batik product innovation. This is possible because the exhibitors could visit each other and discuss the uniqueness of each of their products. Since ancient times batik has developed and is known by the people of Indonesia. The word "Batik" itself has several meanings and meanings. In his book entitled “Batik Tulis”, Hamzuri defines batik as a way to decorate cloth by covering certain parts using a barrier (Trixie, 2020). The barrier substance that is often used in the batik process is wax or wax. Wax is used to draw batik motifs which are then dyed through a dyeing process, then the wax is removed by boiling in hot water. Finally, these processes will produce a piece of batik cloth with a motif that has its own characteristics and meaning (Prasetyo & Singgih, 2016; Trixie, 2020).

October 2 is national batik day. UNESCO has confirmed batik as a masterpiece of oral and intangible human heritage to Indonesia (Parmono, 2013). As a cultured nation, the Indonesian nation is obliged to maintain the preservation of this batik culture. Like other cultural heritages, batik contains wisdom values and this is often neglected in the midst of technological advances, globalization, modernization, and consumerism culture.

Batik tulis is a national cultural asset that has been passed down from generation to generation until now. The uniqueness of Indonesian batik cannot be compared with batik in other countries because Indonesian batik is different not only in the manufacturing process but also in different motifs, because it is related to symbols of life which are full of philosophical values of this nation (Prasetyo & Singgih, 2016).

Batik tulis cannot be separated from people's lives. Since he was still in the womb, born, teenager, married adult, married until he died, batik always accompanies his rituals. The importance of the role of batik can be understood from the frequent presence of batik in various customary activities, traditions and cultural rituals of people's lives.

In the beginning, the culture of batik was a tradition that had been passed down from generation to generation, this caused a batik motif to usually be identified by regional origin or family origin (Trixie, 2020). Some batik motifs can indicate a person's status/degree, even now some traditional batik motifs can only be used by royal families such as the Yogyakarta and Surakarta royal families. There are many types and patterns of traditional batik, but the motifs and varieties are in accordance with the philosophy and culture of each region. Indonesia's fantastic cultural wealth is the trigger for the creation of various traditional batik motifs and types with their own uniqueness (Prasetyo & Singgih, 2016; Trixie, 2020).

The development of science, technology and art in the era of globalization has had a major influence on the development of traditional batik (Parmono, 2013). In fact, globalization and technology have significantly shifted the original local cultural values of Indonesia. The community has the notion that learning science at school or on campus is not related to local culture in society, even though it is farming culture (Tresnawati et al., 2020). So that learning science is just a rote material that is never related to the real world. This is not in accordance with Permendikbud Number 57 of 2014 that every student is able to apply science wisely to protect and maintain cultural preservation.

On October 18, 2014, the World Craft Council designated Yogyakarta as the World Batik City (Adishakti, 2009). This determination was carried out during the 50th anniversary of the World Crafts Council in Donyang City, Zhejiang Province, China, 18-23 October 2014. Batik tulis contains wisdom values and as a cultured nation, the Indonesian nation is obliged to preserve this batik culture (Parmono, 2013). Local wisdom has the potential to be used as a learning resource for students (Yastuti, 2014). That means the local wisdom of batik tulis Yogyakarta can be used as a supporting tool in learning science at school. The fact that occurs in the field, the batik industry is only carried out as a means of daily livelihood business and has not been integrated into learning natural sciences. Even though there are many components in science learning that are found in the local potential of batik tulis Yogyakarta including *ngemplong, molani, mbathik, nembok, mbabar,* and *nglorod*. Based on the description, it shows that batik tulis Yogyakarta can be integrated and can be used as a supporting tool in learning science.

One learning approach that is suitable for 21st century learning is STEAM. STEM is an integration of

learning science, technology, engineering, and mathematics which is currently being promoted to address the challenges of 21st century education (Anggraini & Nurita, 2021). STEM learning is methodology toward providing students with cohesive and conducive learning environments that expand their knowledge in fields relating to technology, engineering, mathematics, and science (Maprasit et al., 2021).

There is a learning approach that can meet the demands of 21st century abilities, namely the science, technology, engineering, art, and mathematics approaches that link the fields of science (science), technology, engineering, art, and mathematics, so that students are given a holistic understanding of the interrelationships of the fields of science through 21st century learning experiences (Haifaturrahmah & Hidayatullah, 2020; Pagsangkanae & Yuenyong, 2019). In learning science, STEAM can train students to apply their knowledge to create designs as a medium for solving environmental problems by utilizing technology.

The STEAM approach recognizes that the Arts introduce a different way of thinking that can fuel the artistic and scientific community, but also society at large, with innovative ideas and actions (Leavy et al., 2023). Learning with the STEAM approach is felt to be able to improve students' abilities because it relates material to everyday life based on local culture. From this, the intention emerged from the researchers to study STEAM aspects in the process of making batik tulis Yogyakarta. Researchers feel that learning using the STEAM approach can help students in learning science.

STEAM education entails an approach for coworking with Science, Technology, Engineering, Arts and Mathematics that, apart from boosting the development of scientific thinking, impulses the development of some of the key skills of the century XXI (Fernández & Checa-Romero, 2023). The philosophy of STEAM integrated education is to provide creative education, covering cutting-edge technology, to students who are already accustomed to advanced technology, so that they do not lose interest in learning in case oftheir inability of keeping up with the pace of technology (Alkhabra et al., 2023).

Method

This study uses a type of qualitative research with descriptive analysis method. The data analysis model used is the Miles and Huberman model which consists of several steps, namely, data collection, data reduction, data presentation, data conclusion. Miles and Huberman's model steps can be more clearly seen in the figure 1.

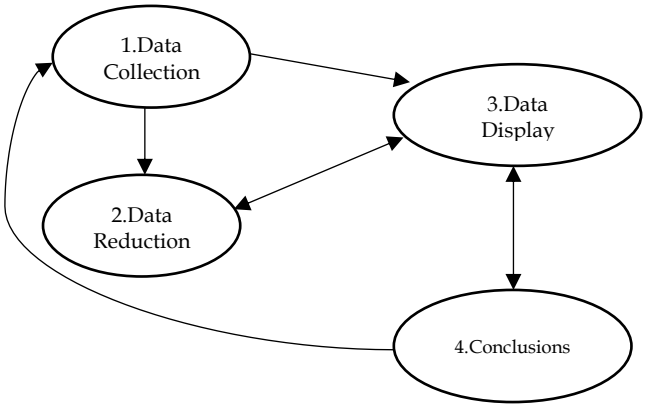

Figure 1. Miles and Huberman Data Analysis Model Stages (Sugiyono, 2019)

As the aim of this study is to examine STEAM in the process of making batik tulis Yogyakarta, the researcher needs to carry out several stages of the analysis model above. Sugiyono, (2019), explains that in qualitative research, data collection is carried out in natural settings or in natural and real conditions. So, in this study primary data were collected through observation, in-depth interviews, and documentation. Meanwhile, secondary data was obtained through literature reviews from several reading sources which also discussed relevant topics. Once obtained, the next step is data reduction. Reducing data means summarizing, choosing the main things, and focusing on the important things. So that the reduced data will provide a clearer picture and make it easier for researchers to collect further data. After the data is reduced, the next stage is the presentation of the data. In qualitative research data will be presented in the form of descriptives or narrative text. After the data is reduced and presented, the data can be concluded in the form of descriptive findings that were previously still dim, and become clearer. These findings can be in the form of concrete evidence, causal relationships, or theories.

The sampling technique in this study used purposive sampling. Purposive Sampling is a data source sampling technique with certain considerations. In this study, several things that were taken into consideration in selecting the sample were the knowledge and involvement of the resource persons as cultural actors such as batik tulis craftsmen. After conducting research through observation, interviews, documentation, and literature review, the information data obtained will be analyzed by triangulation to test the accuracy of the data. This research is expected to be able to present research results that can analyze and describe the basic concepts and principles of science in batik tulis Yogyakarta.

This research was conducted at the Nakula Sadewa Batik center, Triharjo, Sleman, Yogyakarta. The owner of

the Nakula Sadewa Batik center is Mr. Raden Bambang Sumardiyono. He has been named the Father of Indonesian Batik since 2021 and has introduced batik tulis to 32 countries. The research was conducted on Thursday – Sunday, 20-23 October 2022.

The data used is in the form of data from interviews, observations, documentation, and literature review as a complement to the data. Observations and interviews were conducted to find out the process and to find out STEAM aspects in the process of making batik in Yogyakarta. The research was conducted by conducting interviews with Mr. Raden Bambang Sumardiyono. The interviews conducted were unstructured interviews, interviews were carried out by way of the researcher asking questions directly or face to face. The results of the interviews are written in tabular form. Observation data was obtained when the researcher saw the batik process directly at the Nakula Sadewa Batik production house as well as video observations of the batik making process from YouTube.

Result and Discussion

The following is the data obtained from the data collection process and used in this study. The materials needed in the batik process include: cloth, which can be cotton cloth (prima, primis, hanging, or rayon) or silk cloth (super silk, kreb, ATBN, kringkel, or box). The tools needed include: canting, hot wax, frying pan, stove, wok, brush for coloring, dye holder, and dyeing tub.

The canting is the main tool used to make batik tulis, its function is like a pen, namely to take wax/wax and depict it on cloth (Mulyani & Natalliasari, 2020). The canting is made of brass or copper, the handle is made of wood, the size varies according to the size of the line drawing to be made. The stove is a batik equipment whose function is to heat the pan/frying pan which contains the ingredients to be used in batik.

A frying pan or frying pan is used as a place to melt the wax so that it remains runny (Mulyani & Natalliasari, 2020). Wax functions as ink to make images on cloth. Canting can not take the wax, if the night wax hardens. The wax should always be on top of the pan to keep it hot and liquid so it doesn't clog the canting nozzles. This pan is usually made of metal or clay, which is equipped with a handle to make it easier to lift and lower from the stove. Wax wax is a special wax used for batik in the canting process. This wax serves to cover the motifs that have been made on the cloth so as to produce batik patterns with attractive colors. The types of wax wax used for batik include biron wax, swatch wax, crushed wax, and wax wax.

Gawangan or wangkring is a batik tool that is shaped like a wicket and is usually made of wood or bamboo (Mulyani & Natalliasari, 2020). The function of Gawangan is to drape or spread the cloth to be made of batik. A filter is a batik tool used to filter liquid wax so it doesn't clot, stays runny, and is clean. *Jojodog* or the seat needed as a seat by batik craftsmen during the batik process, is usually made of wood, bamboo, iron and plastic.

Buckets or large containers that are commonly used in the process of dyeing and dyeing cloth (Mulyani & Natalliasari, 2020). A mat or tablecloth is a tool that is usually used for mats when casting, this mat is made of sackcloth so it doesn't generate heat when the night wax drips. The way to use it is to cover the base cloth over the craftsman's thighs. *Gerengseng*, is a batik tool used for mopog, namely boiling cloth to remove the wax.

The Process of Making Batik Tulis Yogyakarta
Stage 1: The cloth is in the mordant, dried, and patterned with a pencil.

Figure 2. Making a pattern with a pencil

Method of mordanting: make a solution containing 8 grams of alum and 2 grams of soda ash (Na_2CO_3) in every 1 liter of water used. Stir until dissolved. Boil the solution until it boils then the cloth is boiled for ± other than that, turn off the heat and leave the cloth to soak in the greeting solution overnight.

Stage 2: Based on the pattern that has been made, the cloth is made of batik using a canting that fits the size.

Figure 3. Making batik with strips of wax using a canting

Stage 3: The core part of the image is dabbed with remasol dye (animals, flowers or leaves), then dried. The coloring solution is made from a mixture of remasol-baking soda = 1:1.

Figure 4. Dabbing the image with remasol coloring

Stage 4: The part that was poked at in stage 3 is "walled" and "continued" (closed on both sides with wax).

Figure 5. Walling the part that was dabbed on

Stage 5: The fabric from stage 4 is dyed with the base color. Dried, then "locked" by dipping a cloth in an aqueous solution of "water glass-caustic soda"

Figure 6. Dipping the cloth with the base color

Stage 6: The cloth is dilorod (removed at night) by boiling.

Figure 7. Waxing wax from cloth

STEAM Study in The Process of Making Batik
Science aspects in the process of making batik tulis Yogyakarta

Table 1. Interview Data (Science)

Interviewees' Questions	Answers
Wax is used for making batik, self-producing or buying?	Depend on requirement. If you are going to make a masterpiece, then the wax is used to produce it yourself. If for business, then the night is used, the proceeds buy.
The dyes used for batik, natural dyes or artificial dyes?	Depends on the order. If the ordered batik cloth wants to use natural dyes, then made batik with natural dyes. If batik cloth is ordered with a request for chemical dyes, then the chemical dyes used are dyes that are expensive and environmentally friendly. It's called indigosol dye. Not using naptol and remasol, this is because too much waste is produced.
How canting technique in batik?	Able to take the candle without being full. If you are practicing batik, you can take a little 30%, the handle of the canting cannot go down, it must be upright, 80 degrees, it will flow by itself. If it is lowered 50 degrees it can go everywhere.
What are the basic colors used in batik?	Using naptol: coloring for the base color using naptol, if the streaks run off. This is because the naptol dye has a dark color capable of covering the streaks that spill. Using indigosol: coloring for the basic color of batik, if the streaks are clean. Then you can use bright indigosol dye. Of course, the dye used as a dab with the base color. Indigosol dye is used as a dye. Naptol dyes cannot be used as stain stains.

Interviewees' Questions	Answers
What is the drying process for newly made batik?	Cloth drying should be in the sun. This is so that it is well oxidized.

Technological aspects in the process of making batik tulis Yogyakarta

Table 2. Interview Result Data (Technology)

Interviewees' Questions	Answers
Gawangan is a tool used for what?	Bamboo which can make it easier to print. So that the candle is not easily broken. Wax breaks easily when the cloth is folded. Therefore, this frame makes it easier for the editing process.
What type of stove is used to heat wax in batik?	An electric stove whose temperature is easy to adjust. Do not use an oil stove, because it is not time efficient.

Engineering aspects in the process of making batik tulis Yogyakarta

Table 3. Interview Result Data (Engineering)

Interviewees' Questions	Answers
What are the steps involved in the batik process?	Stage 1: Fabric in mordant, dried, and patterned with pencil. Stage 2: Based on the pattern that has been made, the cloth is made of batik using a canting that fits the size. Stage 3: The core part of the image is dabbed with remasol dye (animals, flowers or leaves), then dried. The coloring solution is made from a mixture of remasol-baking soda = 1:1. Stage 4: The part that was poked out in stage 3 is "walled" and "continued" (closed on both sides with wall wax). Stage 5: The fabric from stage 4 is dyed with the base color. Dried, then "locked" by dipping a cloth in an aqueous solution of "water glass-caustic soda". Stage 6: The cloth is dilorod (removed at night) by boiling.
How long does it take to make batik?	Batik tulis is done as a side job/part-time job. So, no time adrift. Can be 1 week to 1 month. For stamped batik itself is not a side job/part-time job. Usually 2 days of processing, stamped batik is finished.
Are batik tulis motifs already standard as they are today?	Now all over Indonesia, even every district has its own batik motifs. Sleman Regency has a Parijoto batik motif. It is a rare plant on Mount Merapi whose fruit is similar to a pomegranate, small and round. Wates Regency has gebleg batik motifs. Bantul Regency has a batik motif with kates flowers. Wonosari has a walang batik motif. But, unfortunately it is not a philosophical motive. Clothes with Parijoto batik motifs only signify Sleman people. If the Parijoto batik motif is spiked with truntum, then this indicates a Sleman person whose hearts are united.

Arts aspects in the process of making batik tulis Yogyakarta

Table 4. Interview Result Data (Arts)

Interviewees' Questions	Answers
How many batik motifs are made and produced by Batik Nakula Sadewa?	There are many, thousands.
What is the favorite batik motif of Nakula Sadewa Batik?	The favorite batik motifs are the flora and fauna. With flowers and leaves. Big leaves. In fact, once made a tablecloth with a size of 3 meters and valued at Rp. 5,000,000,-.
What about the philosophical value of each batik itself?	For flora and fauna motifs, the outline is given a classic stroke. For example truntum, kawung, and machetes which have classical philosophical values. Truntum batik: usually used for besan with besan. Also worn by princess and son's mantles at banquets. If we look at history, there used to be a duke who had a siri wife. At that time, the duke was going to return the siri wife to his parents, but in the afternoon, the duke saw his siri wife making batik. The batik that is made is truntum batik. Adipati saw the beauty of the batik that was made. In the end, the duke did not return his siri wife to his parents, but was officially married as a wife because he fell in love with the beauty of truntum batik. Therefore, truntum has a philosophical value to unite hearts. Kawung batik: usually worn by people who are over 40 years old. This Kawung describes 4 angles: Qibla, north, east, and south. However, there is a middle point. This midpoint describes going to Allah. Towards Allah Almighty. When entering the age of 40, then his duties in worship must really be prioritized.

Mathematical aspects in the process of making batik tulis Yogyakarta

Table 5. Interview Result Data (Mathematics)

Interviewees' Questions	Answers
Is the size of the batik cloth the same for making jarik and making clothes?	The size of the batik cloth that is made to make jarik and clothes is the same, which is 2.5 meters long.
What is the ratio of comparisons in the coloring of batik?	Comparison for color sharpness. Determine the color, for example to get purple, how much red and how blue to get, if you want to get a light color, then more pink and less blue. If you want to get a light green color, then more yellow, then less blue. Naptol is used only for the base color when dyeing is done.

STEAM Study of The Process of Making Batik in Science Learning, The stages of batik (Wulandari, 2011):
Ngemplong

Ngemplong is the earliest or preliminary stage, starting with washing the mori cloth. The goal is to remove the starch. Then proceed with pengeloyoran, which is putting mori cloth into castor oil or peanut oil which is already in the straw ash. Mori cloth is put into castor oil so that the cloth becomes limp, so that the absorption of the dye is higher. After going through the above process, the cloth is given starch and dried in the sun. Next, the stamping process is carried out, in which the mori cloth is hammered to smooth the layers of the cloth so that it is easy to make batik.

Kanji, namely boeh cloth rinsed in a mixture of water and starch. The size of each ingredient for starch is 2 liters of water with 1.5 ounces of starch. The amount of cloth for one starching is 16 pieces of side cloth. After the starching process, the boeh cloth is dried in the sun to dry. Starching is done so that the texture of the cloth is smoother and tighter or denser so that the quality of the boeh cloth produced is better for making batik (Mulyani & Natalliasari, 2020). In natural science learning materials, the *ngemplong* process: removing starch from cloth is a chemical change.

Nyorek or *memola (molani)*

Nyorek or *memola* is the process of tracing or making patterns on mori cloth by imitating existing motif patterns, or commonly called ngeblat (Mulyani & Natalliasari, 2020). Patterns are usually made on parchment paper first, then traced according to the pattern on mori cloth. This stage can be done directly on the cloth or traced using a pencil or canting. However, in order for the coloring process to work properly, not to break, and to be perfect, the batik process needs to be

repeated on the reverse side of the cloth. This process is called algae.

Figure 8. Canting

Mbathik

Mbathik is the next step, by carving batik wax onto mori cloth, starting with nglowong (drawing lines outside the pattern) and isen-isen (filling in the pattern with various shapes). In the isen-isen process there is the term nyecek, which is making stuffing in a pattern that has been made by adding dots or dots.

Nembok

Nembok is the process of covering the parts that cannot be exposed to the base color using wax. The passage was covered with a thick layer of wax as if it were a retaining wall.

Mbabar

Mbabar is the process of dyeing batik cloth repeatedly in liquid colors to get the desired color. Dip the cloth that has been batik into the liquid dye repeatedly until the desired color. There are two choices of synthetic dyes and natural ingredients. Natural colors for batik coloring are in great demand by consumers from abroad because batik or materials that use natural colors will make the user more comfortable and are guaranteed not to cause allergies (Alamsyah, 2018). The emergence of the return to nature movement, fear of the effects of pollution by synthetic dyes that cause cancer and the desire to produce unique products has encouraged the rise of the use of natural dyes (Pringgenies, 2013).

Before the beginning of the 20th century, batik craftsmen only made batik tulis using dyes from nature such as teak, noni tree, soga, indigo, tall, tegeran, young teak leaves, and others (Alamsyah, 2018). In the process of making batik, dyeing of cloth is the second process after the cloth is spiked with a barrier material. At first the coloring of batik cloth used natural dyes sourced from various types of plants that had color extracts according to what was needed. In its development, the use of natural colors as batik dyes has been abandoned because the process of making natural colors requires a long time, natural colors are not stored for a long time before the coloring process, the durability of natural colors tends to fade easily. The dyeing process takes a long time and must be done repeatedly in order to produce better colors.

Nglorod

Nglorod is the final stage in the process of making a piece of batik cloth using a color barrier (night). In this stage, the batik removes all the wax (wax) by inserting a cloth that is quite dark in color into boiling water. After removal, the cloth is rinsed with clean water and then air-dried. The process of making batik is quite long. The initial process to the final process can involve several people, and the completion of a process stage also takes time. Therefore, it is only natural that batik cloth has a high price.

Science Material That Can Contain the Process of Making Batik Tulis Yogyakarta

Batik has become an Indonesian cultural identity for two reasons, namely the awareness of the public to wear batik clothes because batik is the ancestral heritage of the Indonesian nation and batik itself has uniqueness or characteristics that distinguish it from other nations. Science in making batik is related to several material sub-chapters on the theme of material classification and its changes, including material changes in physics, changes in form, color indicators, and acid-base solutions.

Physical and Chemical Changes

Material changes in physics related to the process of making batik, namely the process of melting batik wax. Melting batik wax in a small pan specially provided in the wax melting process. Which relates to physical changes due to changes that are not accompanied by the formation of new substances. This students can find out with the skills to classify and apply concepts in the aspect of science process skills.

Change of Form

Material changes in form are related to the process of making batik, namely closing batik motifs with wax. By scraping the canting onto the cloth, there is a change in state from liquid to solid which is called solidification. In this case, students can hypothesize about the relationship between science concepts in society and scientific science.

Color Indicator

The color indicator material is related to the process of making batik, namely the coloring process on batik cloth (Tresnawati, 2018). Where in the coloring process using natural indicators and artificial indicators. Natural indicators are obtained from plants such as mahogany

bark produces a reddish brown color, sappan bark or jambe fruit produces a red color. Meanwhile, artificial indicators are produced from chemicals called remasol. Synthetic dye raw materials are dominated by petroleum fractions such as aromatic compounds (benzene, toluene, or xylene).

Acid-Base Solution

The acid-base solution material is related to the process of making batik, namely the removal of wax from batik cloth. Removal of wax using boiling water mixed with starch or soda ash. Soda Ash or sodium carbonate serves to speed up the process of removing the wax from the fabric. Where water mixed with starch will become an alkaline solution so that it can accelerate the loss of wax on cloth (Tresnawati, 2018). Acids and bases are two categories of chemical substances that play an important role in chemistry (Leopold, 2018).

Conclusion

The results of this study indicate that the STEAM (Science, Technology, Engineering, Art, and Mathematics) component is included in the process of making batik tulis Yogyakarta. STEAM components are included in the process of making batik tulis, including *ngemplong, molani, mbathik, nembok, mbabar*, and *nglorod*. The STEAM component in the process of making batik tulis Yogyakarta is also contained in some junior high school science learning materials. As for the process of making this batik tulis, it can be contained in several natural science materials, including: changes in material (physical and chemical changes), changes in form, color indicators, and acid-base solutions. Therefore, the STEAM aspect in the process of making batik tulis Yogyakarta can be taught in junior high school science lessons.

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Author Contribution

The author of this article has made a significant contribution to this research. First, Dwi Agnes Setianingrum, S.Pd. conduct in-depth research to collect the necessary data and information. The author also played a role in interviewing Mr. Raden Bambang Sumardiyono as the Father of Indonesian Batik and was directly involved in making batik at the Nakula Sadewa Batik center. The author also plays a role in designing and making the instruments used in this study, thereby ensuring the accuracy and validity of the data obtained. In addition, the author also plays a role in making teaching materials in the form of a science e-book which contains local wisdom of batik tulis Yogyakarta with the kawung motif, using the STEAM-PjBL approach. This teaching material provides students with a deeper understanding of the relationship between science, technology, art, mathematics, and the local wisdom of batik tulis. Prof. Dr. Jumadi, M.Pd., played a role in tracing references to the Science e-Book, the local wisdom of batik tulis Yogyakarta with the kawung motif, the STEAM approach, the PjBL learning model, creative thinking, and an attitude of love for local culture.

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Conflicts of Interest

Conflicts of interest may arise between researchers and the institutions where they work. For example, if the researcher has an academic obligation or pressure to produce many or prestigious publications, this can influence the choice of research subjects or the interpretation of data to achieve the desired results. Such conflicts can compromise the integrity of research and negatively impact the reliability and validity of findings reported in journals.

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