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STEM
E-CONTENT
3D VIRTUAL REALTY

The Key To Global Life,
Digital Change Of Nature

Total Duration: 1.5 hours

Student's Age: 12-18 Years

Application Area:
- Chemistry
- biology
- textile industry

Keywords: Traditional craft, preparation for the future, chemistry, ecology.

G2 - Biodyes
(Dyeing the Future Green)

Module
- Environmental pollution
- Global Warming

G2 - English Version

Materials:
- **Steel cooker (the pot cannot be used for food afterwards)**
- **Optional: extra natural dye**
- **Wooden spoon**
- **Precision kitchen scale**
- **Cooking thermometer**
- **Sap salt (also named alum or aluminium salt)**
- **Plants that can be used for dyeing/painting**
- **Colander**
- **Cheesecloth**
- **Glass jar**
- **Household vinegar**
- **Natural fibers (f.e. Cotton, linen, wool, silk) as textile samples**

Notes:
- Safety measures must be taken during the boiling process.
- When dyeing, wear a mask and gloves.

Summary

Students will make their own textile dye of natural pigments, such as plant roots, vegetables and so on. This hands-on dye process provides concrete context for theoretical concepts as the invention and use of synthetic pigments and the possibilities with plant based pigments. Participants will include design thinking and question the ecological cost of different methods. They will raise awareness of the fast-fashion industry and its use of chemicals that pollute our air and water, and the harmful effects on human health. While the dye bath is cooling, the session can be extended by a discussion on base materials and bio-fabrication as opposed to traditional production methods for textile. After the dyeing process participants need to examine what to do with waste water and its changing condition. A deeper exploration of the chemistry of pigment and color is also possible if it is adequate for the group.(Picture 1).

Picture 1. Biodyes

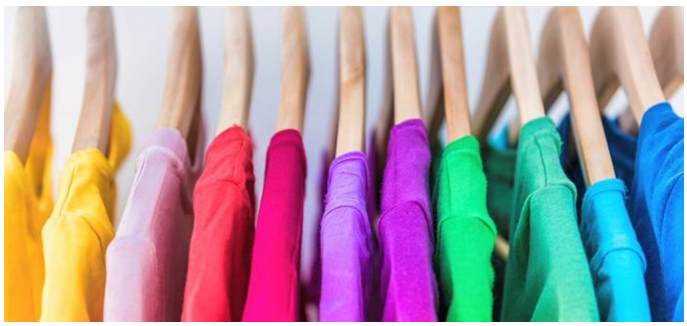
Introduction

Picture 2. Plant based textile

Before the creation of synthetic dyes, people had to use whatever was available to them in the natural world if they wanted to create dye for fabrics, textiles or even ink. But what are natural and synthetic dyes?

Natural sources of dyes such as plant roots, vegetables, berries, insects, are colorants derived from minerals and other biological sources. These were used to color textiles before the introduction of the synthetic ones. Natural dyes are biodegradable, non-toxic and non-allergenic, making them generally better for the environment and for use around humans. While producing this natural dye, most of them can also be used for other purposes. Plant-based fabric dyes do take a longer time to prepare and use and it is almost impossible to get the same color results (Picture 2).

Synthetic dyes, dyes that are chemically manufactured, appeared in the 19th century when William Perkin, a young British chemist, tried to create synthetic quinine for medical use. In 1856, Perkin found a synthetic mauve color that was some kind of purple and recognized its potential as a dye. Other scientists followed his lead, and in 1869 an artificial red dye was successfully created. Many other dyes came from coal tar, which means they're connected to fossil fuels. There was a rise in the development of synthetic dyes and the growth of industrial fabric production (Picture 3).



Picture 3. Clothes based biodyes

Synthetic dyes started to be preferred due to ease of use and color variability, but they contain ozone-depleting chemicals such as CFCs, HCFCs, aromatic hydrocarbons or volatile solvents. They include lead, heavy metals and toxic chemicals, such as mercury, lead, chromium, copper, sodium chloride, toluene, or benzene.

Picture 4. Biodyes

The current fast fashion industry relies heavily on chemicals, from the pesticides used to grow crops to the dyes and finishes applied to garments. The fashion effects on our environment are far reaching; they include water pollution from dyes used in the manufacturing process, air pollution in the form of toxic emissions released during production, and a massive increase in textile waste. It is also responsible for deforestation, as trees are cut down to make way for crops used to produce textile fibers. In addition to this, due to low quality fabrics used by fast fashion companies garments break down more quickly than garments produced under ethical labor standards, meaning consumers have to buy new clothes more often – leading to further over-consumption. It has a harmful effects on human health (Picture 4).

Recently, however, the world is waking up to the harmful social and ecological impacts of synthetic dyes due to the toxic by-products they produce. But could naturally dyed clothing be a sustainable solution, and what exactly are natural dyes?

Considerations

- Safety measures must be taken during the boiling process.
- When dyeing, wear a mask and gloves.

Aims of the activity

In this activity, students become aware that synthetic dyes used today impact environmental pollution, and understand how natural root dyes are applied through non-environmentally safe fabric processes to increase the spread of these dyes. The main objectives of this group work are learning by doing (DIY), and expressing themselves in view to improve their skills.

Activity Process

Before Activity

Before the activity:

- The area used for the activity needs to be organized.
- All the materials required for the activity are provided (natural dyes, wooden spoon...)

The following questions are asked to the students' attention:

- How do you think textile dyeing currently works?
- Why and how do you think this poses an ecological risk?
- What are the long lasting effects of using synthetic dyes on the environment?
- Where does fast fashion end up?
- How can we raise awareness?
- Could naturally dyed clothing be a sustainable solution?

Let's Start

1 Orientation and Context:

In this step students inquire and discuss synthetic dyes vs natural dyes. First, do a short review of dyes. Comment on the picture and discuss the history of dyes (Picture 5).

Picture 6. Natural dyeing

Orange: Carrot, onion skins, turmeric (roots), giant coreposis (any part of the plant), bloodroot (roots), barberry (any part of the plant), eucalyptus (leaves)

Red-Brown: When making red dyes be sure to slowly raise the temperature of the dye vat. Reds have a tendency to go brown when too much heat is applied. The maximum temperature for red dyes is 180c. Never boil! Pomegranate, beet, young bamboo, chocineal (insect), lac (insect), hibiscus (flower), madder (root), red elderberry (berries), sumac (berries), beetroot (root vegetabel), brazilwood (wood), st john's wort (whole plant), sycamore (bark), cadmium (mineral), avocado (fruit) ...

Reddish purple: Red sumac fruits, red basil (whole plan), dark red hibiscus (flower), daylilies (flowers), vermillion (mineral), lac (insect)...

Pink: Strawberries, cherries (fruit), red and pink roses (flower), avocado (shells and core of the fruit), lichens (whole plants), white bedstraw (roots)

Yellow: Daphne leaf, sunflower leaves, dandelion flowers, red pepper, turmeric (roots or powder), celery leaf, lilac branches, bayleaves (leaves), saffron (stamens), marigold (flower), Queen annes lace (flower), st. john's wort (plantà, golden rod (flower), osage orange (inner bark or shavings), tea (leaves), brown onions (skins), larkspur (plant), chromium (mineral), lead (mineral), titanium (mineral), annato (seeds)

Brown: Dandelion (roots), oak bark (bark), walnut (hulls), coffee (grinds), acorns, yellow dock (plant), ivy (woody stems), golden rod (shoots), tea (leaves), sumac (leaves, powder), birch (bark), brown clay (clay soil), limonite (clay), octopus/cuttlefish (ink)

Green: Artichoke, spinach (leaves), mint (leaves), lion's mouth (flower), lilac, grass, nettle, banana, peach (leaf), tea tree (flower), larkspur (plant), red onion (skins), yarrow (flowers), chamomile (leaves), black-eyed susans (flowers), nettle (leaves), dyer's broom (plant), chromium (mineral)

Blue: Red cabbage, red berry, blueberry, purple grapes, cranberry (shell), dogwood (fruit), hyacinth (flowers), indigo (foliage), red maple tree (inner bark), woad (leaves), mulberries (fruit), elderberries (fruit), blueberries (fruit), cornflower (flowers), blackbeans (dried bean), cobalt (mineral), copper (mineral), murex snail (trunculus)

Gray-black: Berries, walnut (hulls), oak (galls), sumac (leaves), iris (roots), black beans (dried bean), titanium (mineral), carbon (mineral)

2 Dyeing process:

Review some dyeing recipes that have been done a few times, and find which factors influence our results (temperature, time, quantity, etc.).

Recipes vary based on which dye plants are available locally. Change the recipe according to the region you're teaching. In the North-East we use weld and madder (yielding yellow and red/orange tints).

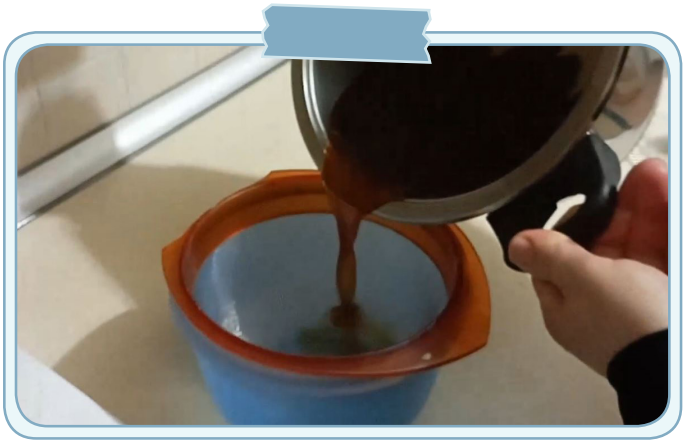
1. Moist the fabric material. Fabric material could be natural fibers for example cotton, wool, linen, etc (Picture 7).

Picture 7. **Fabric amterial**

2. Weigh the natural dye material and pre-moisted fabric. For reference, the average material should be 250 grams separately.

3. Place the natural material of your choice in the stainless-steel pot according to the color you want to dye the fabric. Add up to three times the amount of water (as the natural material) and boil for about an hour until you get a good color (Picture 8).

Picture 8. **Place the material**



Picture 9. **Filtration**

4. Filter out the dye and add SAP salt (also named alum or aluminium salt) to the dye.

5. Heat up to the required temperature in the recipe you select (this will usually be below the boiling point around 90°C). Place the fabric you want to dye in the filtered dye and let it boil for about one hour and mix it occasionally. The students monitor the temperature with a cooking thermometer. The fabric will get a beautiful color within one hour, but remember, the color of the fabric will be lighter after drying. So, check the color of the fabric during the boiling period. It may take more than one hour for the fabric to fully hold dark colors. If you want to keep the fabric longer in the dye, turn off the heat and leave the fabric in the dye until you get the color you want (Picture 9).

6. Let the fabric cool down, then rinse it with cold water.
7. Leave the fabric overnight in cold water with some vinegar to fixate it (Picture 10).
8. Leave the painted clothes to dry.

Picture 10. **Leave fabric**

3 Presentation

- Present the eco-friendly plant-based ink. Show your textile examples and explain that to dye this textile, there was no environmental damage to the world. Students can select any of the natural plant samples that give the colors to the fabrics and experiment with it.
- Decide how students are going to raise awareness. For example students can sell t-shirts made with synthetic dyes and natural ones at the same time to collect the point of view among their friends based on the results.

Assesment

Evaluation

- The design of students can be displayed within the school. Different products can be created by diversifying waste materials used.

Goals	Must be Improved (1)	Medium (2)	Good (3)	Very Good (4)
Express yourself	(.....)	(.....)	(.....)	(.....)
Present an idea	(.....)	(.....)	(.....)	(.....)
Supply materials	(.....)	(.....)	(.....)	(.....)
Getting required Safety Precautions	(.....)	(.....)	(.....)	(.....)
Design visualization	(.....)	(.....)	(.....)	(.....)
Communication ability in tag distribution	(.....)	(.....)	(.....)	(.....)
Presentation ability	(.....)	(.....)	(.....)	(.....)
Total				

Links

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