

FOR EXCELLENCE IN MIAMI-DADE PUBLIC SCHOOLS

2024
2025

Ideas with

IMPACT

STEAM

**Indigo: Color that
Changed the World**

IDEA PACKET SPONSORED BY:



**School District Education
Foundation Matching
Grant Program**

INDIGO

COLOR THAT CHANGED
THE WORLD

INDIGO EXPLORATION: BLENDING SCIENCE AND ART

ALINA RODRIGUEZ, ALINARODRIGUEZ@DADESCHOOLS.NET



TABLE OF CONTENTS

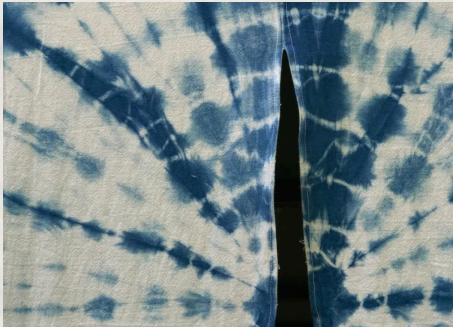


Table of Contents

Add a little bit of body text

Introduction

1. **Title**
2. **Table of Contents**
3. **Goals and Objectives**
4. **Florida State Standards**
5. **Course Overview**
6. **Lesson Plan Overview**
7. **Lesson Plan Understanding Eco Printing- Introduction to Indigo**
8. **Lesson Plan-The Magic of Color Chemistry**
9. **Lesson Plan-Japanese Shibori**
10. **Types of Shibori**
11. **Lesson Plan-Africa and Indigo**
12. **Cassava Flour Recipe**
13. **Yoruba Textile Adire**
14. **Lesson Plan-Indigofera Chemistry**
15. **Indigofera Chemistry-plant parts**
16. **Understanding the Chemistry behind Indigo**
17. **Lesson Plan-Collaborative Indigo Dye Project**
18. **Lesson Plan-Japanese Tsutsugaki**
19. **Lesson Understanding the Chemistry Behind Indigo Dyeing**
20. **Lesson Understanding the Chemistry Behind Indigo Dyeing**
21. **Historical and Cultural Impact - Activities and Objectives**
22. **Historical and Cultural Impact - Activities and Objectives**
23. **Gallery**
24. **Resource List**
25. **Materials List**
26. **Cheat Sheet**
27. **Glossary**
28. **Resource**
29. **Gallery**

GOALS AND OBJECTIVES

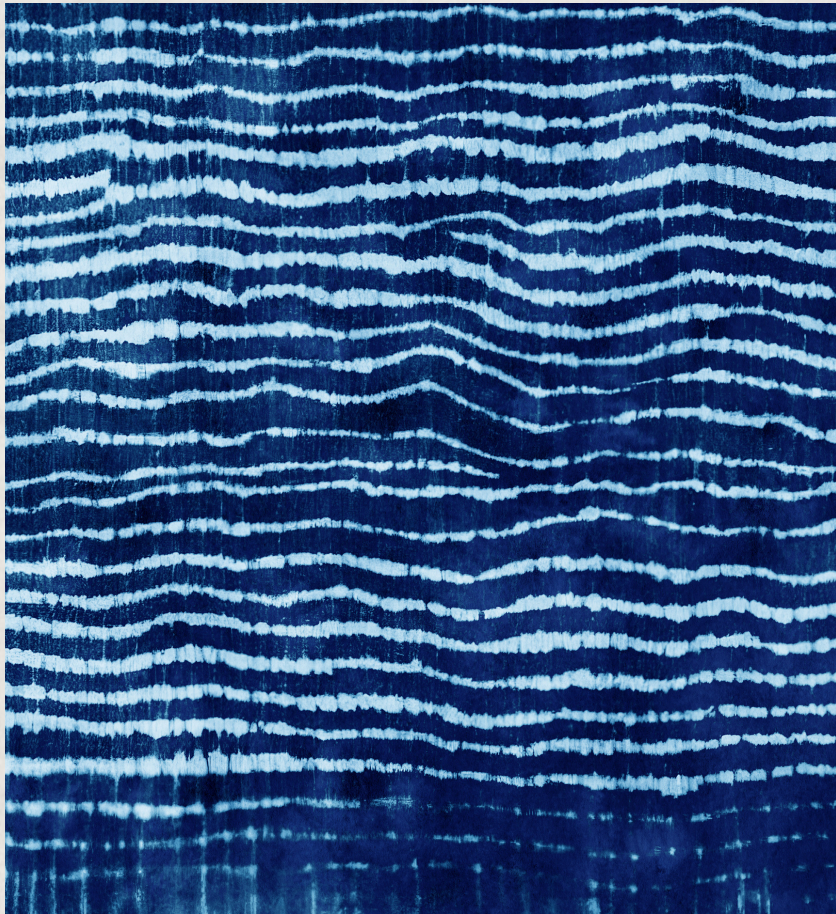


Goals and Objectives of the Indigo Dyeing Curriculum for Grades 2-8

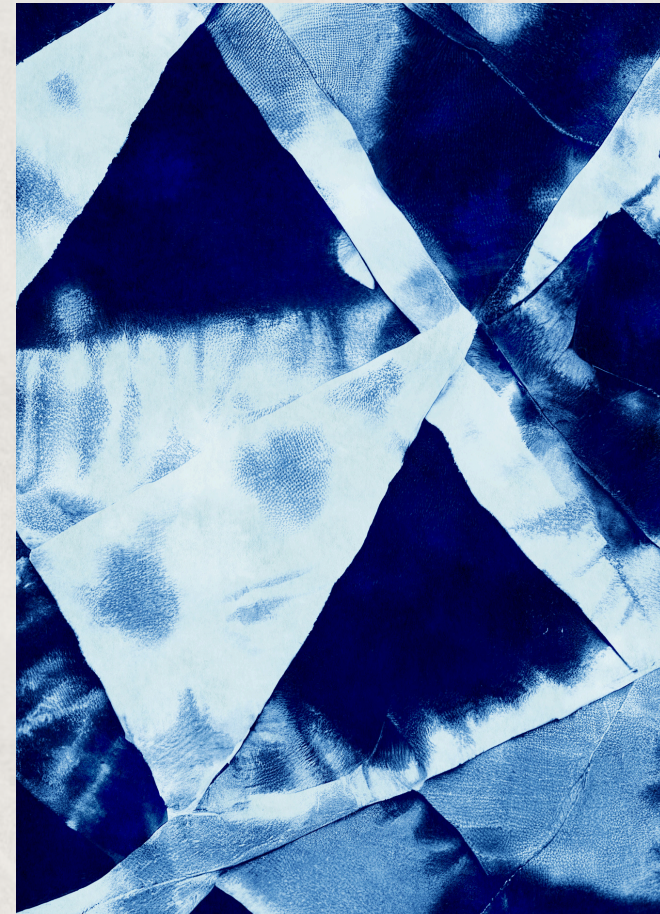
Overall Goals:

1. Scientific Understanding: Develop a foundational understanding of the chemistry behind indigo dyeing, including concepts such as oxidation, reduction, and hydrogen bonding.
2. Historical Awareness: Explore the historical significance and cultural impact of indigo dyeing across various civilizations.
3. Artistic Skills: Cultivate artistic skills through the practice of traditional and modern indigo dyeing techniques, such as tie-dye, shibori, and eco-printing.
4. Botanical Knowledge: Gain knowledge about the Indigofera plant, including its growth conditions, biological characteristics, and uses.
5. Interdisciplinary Learning that integrates science, history, art, and botany.
6. Students will experiment with creating an indigo vat and understand the safety precautions used during the process.
7. Students will dye fabrics using indigo dyes and create original works of art.
8. Students will understand the chemical process of indigo and be able to explain scientific concepts in writing.
9. Students will learn about chemical reactions and the concept of oxidation and reduction.
10. Students will practice Tie-dyeing t-shirts with various designs using indigo and learn the ancient history of the craft. Students will practice the art of Indigo resist dyeing and explore 3 techniques of shibori.
11. Students will create geometric shibori designs. Students will collaborate in making samplers of indigo-dyed shibori designs and create a student show using the artworks.

FLORIDA STANDARDS



SC.5.N.2.2
SC.5.N.1.3
VA.2.C.1.1
VA.2.F.1.1
VA.2.O.2.1
VA.2.S.1.1
VA.3.C.1
VA.3.S.1.2
VA.3.H.1.1
VA.3.O.2.1
VA.4.C.1.1
VA.4.O.1.1
VA.4.F.1
VA.5.C.1.2
VA.5.C.1
VA.5.H.1
VA.68.S.1
VA.68.C.1.1
SC.912.N.2.1
SC.8.L.18
MA.5.GR.1
MA.5.M.1 :



COURSE OVERVIEW

This curriculum is designed to introduce students from second to 8th grade to the world of indigo dyeing. Through age-appropriate activities and interdisciplinary lessons in chemistry, biology, organic chemistry, botany, and visual art, students will explore the historical, cultural, scientific, and artistic aspects of indigo dyeing. With a history spanning 5,000 years, indigo remains as pertinent today as ever, particularly with the iconic blue jeans. K-2 will explore color indigo through storytelling and simple experiments using finger painting and tie-dye activities. Grade 3-5 will experiment with shibori dyeing techniques and study the lifecycle of the indigo plant. Grades 6-8 study the historical and cultural significance of indigo, the science of extracting dye from the plant, and shibori dyeing projects.

To introduce the Color Chemistry that Changed the World students will practice eco-printing by placing fresh indigo leaves on fabric, covering it with another piece of cloth, and pounding gently with a mallet or hammer until the leaf print appears. Students will learn the chemistry of the indigo dyeing process which involves dipping fabric into a dye bath that is yellow-green color and leaving it under the surface for 5-10 minutes. When the fabric is exposed to air it turns indigo blue. Students will dip strips of test fabric to experiment with color saturation. Students will study the ancient history of indigo dating back to 5,000 years ago. They will present a drawing indicating a historical period in which indigo was used. Students will explore botany and Indigo harvested from the leaves of the Indigofera plant that grows in tropical zones in Africa and China. They will create a detailed botanical drawing of the plant. Students will learn hapa zome, the chemistry of dyeing using indigo on paper by making wrapping paper. Students will study the art of resisting dying using shibori by tying, gripping, and folding fabrics leaving undyed white patches and designs.

Shibori is a Japanese dyeing technique with equal parts art projects, science experiments, and geometry lessons. Students will design geometric patterns by folding, wrapping, and twisting cloth before dipping it into natural indigo. Not only will students learn how to dye beautiful textiles with the ancient plant dye indigo but also the fundamentals of science, experimentation, and its history. Students analyze the relationship structure among chemistry concepts such as oxidation and reduction to organic and chemical indigo. Participants will make magic after exposing the dyed fabrics to the air, oxidizing the green color to a deep blue. Activities will cover the chemistry of dyeing using indigo on paper, natural fabrics, and yarns. It will cover hydrogen bonding often associated with the water molecule and the binding of indigo to fibers, as a cause for the fading of blue denim clothing. Another chemistry-associated lesson is oxidation & reduction. Because indigo is insoluble in water, it cannot easily be used in that form as a dye. However, converting it, by oxidation, to indigo makes the dye soluble in water and able to react to color bars.

This project on indigo dyeing blends ancient history, chemistry, and the new arts in an unusual mixture – in this case, using innovative and simple practical activities involving the intense color blue as an effective way to attract the students' attention. Throughout the curriculum, connections are made to other subjects such as history, geography, environmental science, and cultural studies to provide students with a holistic understanding of the interdisciplinary nature of indigo dyeing. The lessons are adaptable to all grade levels and aim to inspire students of all ages to appreciate the beauty, complexity, and cultural significance of indigo dyeing while fostering critical thinking, creativity, and a deeper understanding of the world around them.





LESSON PLANS

Overview

This comprehensive curriculum introduces students to the multifaceted world of indigo dyeing, blending science, history, art, and botany. Through hands-on activities and interdisciplinary lessons, students will explore the chemistry behind indigo dyeing, learn about its historical significance, and create their own indigo-dyed textiles using traditional and modern techniques.

WEEK 1 & 2-UNIT 1-GR. 2-3UNDERSTANDING ECO PRINTING-VISUAL ARTS

Week 1: Understanding Indigo

- **Grades 2-3**
- **Introduction to Natural Dyes**
- **Objective:**
- **Botanical Knowledge:** Gain knowledge about the Indigofera plant, including its growth conditions, biological characteristics, and uses.
 - **Begin with a presentation on Indigo. Arts & Culture**
- **Discussion**
 - Engage students in a discussion on different colors and their sources including Indigo, one of the colors of the rainbow, right between blue and violet.
- **Demonstration** Demonstrate how to eco-print using natural indigo leaves on paper.
- Place indigo leaves on the paper, cover with another piece of fabric, and gently pound with a mallet, hammer, or rocks.
- **Hands-on Activity-Eco-Printing Activity (30 minutes).**
- Let students create their own eco-printed designs in pairs or small groups.
- **Summarize** the key points learned about indigo. Show images of the Indigofera Plant

Week 2: Eco-Printing with Indigo Leaves/Using Indigo leaves on fabric (Etsy sells the leaves for \$1 an ounce. You can also use regular leaves instead to imitate the process.

- **Introduction to Eco-Printing**
- Explain the process of eco-printing using simple terms and visuals.
- Demonstrate placing leaves inside a folded fabric, and gently pound until the print appears.
- **Hands-on Activity**
- Provide each student with fresh green leaves, muslin fabric or paper, and mallets or rocks. Students will use fabric, folded in half, and will place the leaves inside. They use mallets or hammers to tap on and make a print of the leaves. These prints can be further embellished with natural dyes like turmeric, black beans, or onion skins.
- **Materials.** muslin fabric, or paper, old hammers covered in felt, fresh leaves of various sizes
- **Botany Lesson**
- Discuss the parts of the Indigofera plant and show real or pictorial examples. See page 16.
- **Class Discussion**
- Talk about their eco-printing experience and share prints.



To introduce the Color Chemistry that Changed the World the students will practice eco-printing by placing fresh indigo leaves on fabric, covering it with another piece of fabric, and pounding gently with a mallet or hammer until the leaf print appears

Resources: Smithsonian
Extension
Video-[Leaf Pounding in Japan](#)




Jacquard Products' Indigo Tie Dye Kit



Share

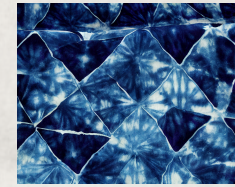
Indigo is one of the
oldest dyes used for
coloring fabrics.

Watch on  YouTube

Resources

Week 3-4: Art Lesson: Exploring Indigo Through Tie-Dye

- Grades 2-3/4-5
- Objective:
- Students will learn about the history and significance of indigo and create their indigo-dyed fabric using tie-dye techniques.
- Introduction. Begin with a brief story about indigo, explaining its origins and importance throughout history. Read the book "My Indigo World: A True Story of the Color Blue".
- Show pictures of indigo plants, ancient indigo-dyed fabrics, and modern items like blue jeans. Blue online reading book.
- Discuss the cultural significance of indigo in different parts of the world.
- Demo. Explain that tie-dyeing is a method of dyeing fabric in which the fabric is tied in different ways to create patterns.
- Show different tying techniques, such as spirals, crumples, stripes, and bullseyes.
- Demonstrate how to secure the fabric with rubber bands to create these patterns.
- **Preparing the Dye (10 minutes)**
- Explain safety precautions for working with dye (wearing gloves and masks).
- Show how to prepare the indigo dye according to the instructions on the dye package.
- Pour the dye into squeeze bottles for easier application.
- Hands-on Activity Creating the Tie-Dye Patterns (30 minutes)
- Give each student a piece of white cotton fabric or t-shirt and rubber bands.
- Allow students to use the tying techniques to create their patterns.
- Once tied, students will use the squeeze bottles to apply the indigo dye to their fabric. Encourage them to experiment with different amounts of dye for varying effects.
- Place the dyed fabric in plastic bags to let the dye set (follow the dye instructions for setting time).
- **Rinsing and Revealing the Patterns (15 minutes)**
- After the dye has been set, demonstrate how to rinse the fabric in cold water until the water runs clear.
- Carefully remove the rubber bands to reveal the patterns.
- Show how to wash the fabric in a washing machine to remove any excess dye and set the color.
- Assessment:
- Participation in the discussion and activities. Creativity and effort in the tie-dye project.
- Understanding of the historical and cultural significance of indigo, as demonstrated through the discussion and reflections.



Materials Needed:

- White cotton fabric pieces (e.g., T-shirts, bandanas, or fabric squares)
- Indigo dye (either natural or synthetic).
- Rubber bands
- Plastic squeeze bottles (for dye)
- Plastic table covers or garbage bags (to protect surfaces)
- Plastic gloves (to protect hands)
- Buckets or large bowls (for dyeing)
- Water
- Aprons or old shirts (to protect clothes)
- Access to a sink (for rinsing and setting the dye)

FUN FACTS ABOUT INDIGO

1. **COLOR OF THE RAINBOW:** INDIGO IS ONE OF THE COLORS OF THE RAINBOW, RIGHT BETWEEN BLUE AND VIOLET.
2. **SYMBOLISM:** MANY CULTURES CONSIDER INDIGO TO SYMBOLIZE WISDOM, SPIRITUALITY, AND MYSTERY.
3. **NATURAL AND SYNTHETIC:** WHILE NATURAL INDIGO COMES FROM PLANTS, SYNTHETIC INDIGO IS MADE BY CHEMISTS IN LABS.
4. **JEANS:** WITHOUT INDIGO, WE WOULDN'T HAVE BLUE JEANS, ONE OF THE MOST POPULAR TYPES OF CLOTHING IN THE WORLD!

WEEK 3 & 4 TIE DYE TECHNIQUES



INSTRUCTIONS ON HOW TO USE RIT DYES TO TIE DYE FABRIC

THE HISTORY OF TIE-DYE IS MOSTLY ASSOCIATED WITH THE 1950-60S HIPPIE MOVEMENT AND WHAT WE COMMONLY KNOW AS MODERN TIE-DYE NOW.



Resources

WEEK 1 & 2- JAPANESE SHIBORI GR. 4-5 VISUAL ARTS

Shibori Indigo Dyeing

- **Grades 4-5**

- **Objective:** Students will learn about the Japanese art of Shibori and its cultural significance.
- Students will understand the basic process of dyeing fabric using indigo.
- Students will create their Shibori-dyed fabric using traditional techniques.

Introduction to Shibori and Indigo (15 minutes) Google Arts and Culture

- Begin with a brief story about Shibori, explaining its origins in Japan and its traditional methods.
- Show pictures and videos of Shibori techniques and finished products.
- Explain the significance of indigo in Shibori and how it has been used throughout history.
- **Demonstration** Explain that Shibori is a Japanese technique for dyeing and patterning cloth that involves securing fabric before dyeing it to create patterns that resist the dye.
- Demonstrate different Shibori techniques, such as:(see page 12)
- Kanoko Shibori: Tying fabric with rubber bands to create circular patterns.
- Itajime Shibori: Folding fabric and clamping it between wooden blocks to create geometric patterns.
- Kumo Shibori: Binding fabric with string and small objects like marbles or stones to create spider-like patterns.
- Show how to secure the fabric using rubber bands, string, or small objects.
- **Hands-on Activity Preparing the Dye (10 minutes)**
- Discuss safety precautions for working with dye (wearing gloves and aprons).
- Show how to prepare the indigo dye according to the instructions on the dye package.
- Pour the dye into squeeze bottles for easier application.
- **Shibori Dyeing Activity (25 minutes)**
- Distribute white cotton fabric pieces and materials for binding (rubber bands, strings, small objects, wooden blocks).
- Guide students through the process of creating their own Shibori patterns using the demonstrated techniques.
- Once fabrics are bound, students will use the squeeze bottles to apply the indigo dye to their fabric.
- Place the dyed fabric in plastic bags to let the dye set (follow the dye instructions for setting time).
- **Rinsing and Revealing Patterns (10 minutes)**
- After the dye has been set, demonstrate how to rinse the fabric in cold water until the water runs clear.
- Carefully remove the bindings to reveal the Shibori patterns.
- Show how to wash the fabric to remove any excess dye and set the color.
- **Discussion and Reflection (10 minutes)**
- Have students display their finished Shibori-dyed fabrics.
- Discuss the different patterns and techniques used by the students.
- Reflect on what they learned about Shibori and its historical and cultural significance.

Understanding Three Types of Japanese Shibori

Shibori is a traditional Japanese dyeing technique that involves folding, twisting, and binding fabric to create intricate patterns. Here are three popular types of Shibori techniques. [See more](#)

Kanoko Shibori (Tying)

Kanoko Shibori is similar to the Western tie-dye technique and is characterized by creating circular patterns on the fabric.

How It's Done:

- **Materials Needed:** Fabric, rubber bands, or string.
- **Technique:**
 - The fabric is pinched and bound with rubber bands or string at various points.
 - The tighter the binding, the more pronounced the white circles will be after dyeing.
 - After binding, the fabric is dyed. The bound areas resist the dye, creating patterns.
- **Result:**
 - This method produces a series of circular designs on the fabric, often resembling rings or dots.
 - The patterns can vary based on how tightly and where the fabric is bound.



Itajime Shibori (Clamping)

Itajime Shibori involves folding the fabric and clamping it between two objects, usually wooden blocks, to create geometric patterns.

How It's Done:

- **Materials Needed:** Fabric, wooden blocks, and string or clamps.
- **Technique:**
 - The fabric is folded into various shapes, such as squares or triangles.
 - Wooden blocks are placed on either side of the folded fabric and then clamped together tightly.
 - After clamping, the fabric is dyed. The areas covered by the blocks resist the dye, creating patterns.

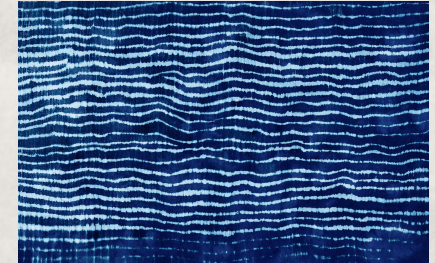


Kumo Shibori (Binding)

Kumo Shibori involves pleating and binding sections of the fabric to create spiderweb-like patterns.

How It's Done:

- **Materials Needed:** Fabric, small objects (like marbles or stones), and string.
- **Technique:**
 - Small objects, such as marbles or stones, are placed inside the fabric.
 - The fabric is then tightly bound around these objects with string.
 - After binding, the fabric is dyed. The bound areas around the objects resist the dye, creating patterns.



Materials Needed:

- Indigo dye (natural or synthetic)
- Rubber bands
- Small wooden blocks, marbles, or stones (for binding)
- Twine or string
- Plastic squeeze bottles (for dye)
- Plastic table covers or garbage bags (to protect surfaces)
- Plastic gloves (to protect hands)
- Buckets or large bowls (for dyeing)
- Water
- Aprons or old shirts (to protect clothes)
- Plastic bags (for setting the dye)
- Access to a washing machine (for rinsing and setting the dye)
- Pictures and videos showing Shibori techniques and finished products

WEEK 1 & 2- AFRICA AND INDIGO ADIRE GR. 6-7



Week 1-2: Art Lesson: Indigo in the World-Africa

- **Adire Eleko & Senufo Cloth-Africa**
- **Unit 1: Historical and Cultural Context / The History of Indigo -**
 - **ObjectiveS:** Students will explore the traditional textile arts of Indigo Adire Eleko from Nigeria and Senufo cloth from Côte d'Ivoire. They will learn to identify and create lines, shapes, patterns, and rhythms inspired by these cultural textiles.
- **Discuss Images of Indigo Adire Eleko and Senufo cloth. Show**
https://artsandculture.google.com/story/adire-the-art-of-tie-and-dye-pan-atlantic-university/_QVxsVP8AxQtIw?hl=en
- **Cultural Context:**
- **Adire Eleko:** A resist-dyeing technique from Nigeria, traditionally using indigo dye and cassava paste or wax to create intricate patterns.
- **Senufo Cloth:** Originating from the Senufo people in Côte d'Ivoire, these textiles often feature geometric patterns and symbols that tell stories or convey cultural significance.
- **Present images of Indigo Adire Eleko and Senufo cloth to the students.**
- **Discuss the visual elements: lines, shapes, patterns, and rhythm.**
- **Identify the differences and similarities in the styles and techniques used in each textile tradition.**
- **Demonstration** Demonstrate how to use wax or cassava paste to resist dye (Adire Eleko technique).
- **Hands-on Activity** Students will sketch a design for their textile, incorporating the elements of lines, shapes, patterns, and rhythm.
- **Students will incorporate cultural significance and storytelling aspects of their design.**
- **Students will practice on small fabric samples before creating the final piece.**
- **Students apply their design to the fabric using the techniques discussed.**
- **Dye the fabric with indigo dye or use fabric paint for the final creation.**
- **Summarize** Discuss different types of lines (straight, curved, zigzag, etc.) found in Adire Eleko and Senufo cloth.
 - **Hands-on Activity**
 - **Students apply their design to the fabric using the techniques discussed.**
 - **Dye the fabric with indigo dye or use fabric paint for the final creation.**
 - **Assessment:**
 - **Participation in discussions and activities.**
 - **Quality and creativity of the sketches and final textile design.**
 - **Understanding of the cultural context and techniques used in Indigo Adire Eleko and Senufo cloth.**

Cassava Flour Recipe for Adire Eleko Resist

INGREDIENTS: 4 LITERS OF WATER TO 1 KG OF CASSAVA
FLOUR
STRAINER
SALT

METHOD:

- ADD HOT WATER TO CASSAVA FLOUR AND MIX
- STRAIN THE MIXTURE TO REMOVE LUMPS.
- DIVIDE AND ADD SALT

INGREDIENTS: 4 LITERS OF WATER TO 1 KG OF CASSAVA
FLOUR
STRAINER
BLENDER
HEAT SOURCE AND COOKING POT
SALT
LIQUID STARCH

COOKING METHOD

- FLOUR & WATER ARE MIXED, AND COOKED UNTIL THICKENED.
- PASTE IS STRAINED
- IF THE PASTE IS TOO THICK RETURN TO THE BLENDER AND ADD LIQUID STARCH.
- THE BATCH IS DIVIDED AND SALT IS ADDED TO HALF.

Materials Needed:

- White cotton fabric squares
- Indigo dye or fabric paint
- Wax or cassava paste (for Adire Eleko)
- Brushes, stencils, or stamps
- Pencils and paper
- Rulers and compasses
- Scissors



Figure 46
Digi(Mirror)



Figure 47
Abebe(Fan).

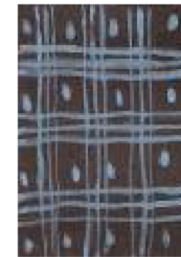


Figure 48
Eni Pakiti(Mat)

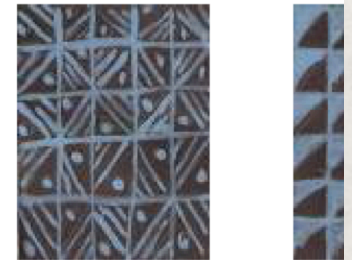


Figure 49
Gangan(Talking Drum)
(Quoranic Slate)



Figure 51

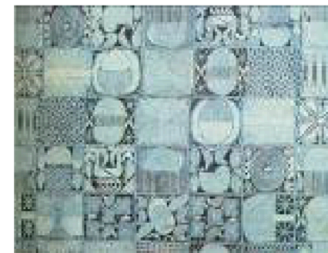


Figure 52

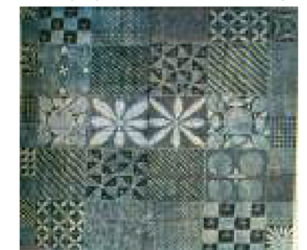


Figure 54

Resources:

- <https://createartwithme.com/adire-eleko-cloth-senufo-animal-art-lesson-part-1/>
- https://artsandculture.google.com/story/adire-the-art-of-tie-and-dye-pan-atlantic-university/_QVxSVp8AxQtIw?hl=en
- <https://www.vam.ac.uk/articles/adire-tied-and-dyed-indigo-textiles>

Yoruba Textile-Adire

Some Adire motifs and their meanings



Figure 21
Ooya(Comb).

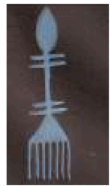


Figure 22
Ipon (Ladder)



Figure 23
Agboorun.
(Umbrella)

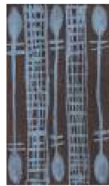


Figure 24
Opo Ile Mapo
(Mapo pillars)



Figure 25
Agbo'le
(Compound)



Figure 26
Sekeseke(Cuffs)



Figure 27
Sekere(Gourd Rattle).



Figure 28
Kokoro(Key).



Figure 29
Opon Iro(Tray of Lies)

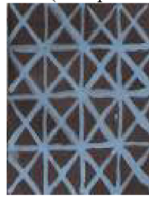


Figure 30
Waya(Wire)



Figure 1
Adan(Bat) motif.



Figure 2
Oobe (smaller
species of bat)



Figure 3
Oga(Chamele)



Figure 4
Alangba (Lizard)

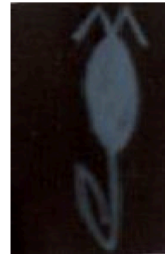
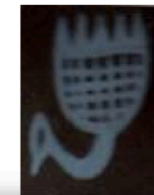


Figure 5
Igbin (snail).



Figure 1 Figure 2 Figure 3 Figure 4 Adan(Bat) motif. Oobe (smaller Oga(Chamele) Alangba (Lizard) Igbin (snail). specie of bat)



Adire is a type of indigo-dyed cotton cloth that originated in Abeokuta, Nigeria, and is traditionally made and worn by Yoruba women

WEEK 6: INDIGOFERA PLANT STUDY

WEEK 7: SIMPLE CHEMISTRY OF DYEING - ACTIVITIES AND OBJECTIVES

Objectives:

1. **Understand the Basics of the Indigofera Plant:**
 - Identify the Indigofera plant and its uses.
 - Understand the history and cultural significance of indigo dye.
2. **Explore the Chemistry of Dyeing:**
 - Learn about the chemical process of dyeing with natural indigo.
 - Conduct simple dyeing experiments to observe chemical reactions.
3. **Engage in Hands-On Activities:**
 - Dye fabric samples using a natural indigo solution.
 - Observe and record changes in fabric color and texture.
 - Lesson Activities:
 - 1. Introduction to Indigofera Plant (15-20 minutes)
 - Discussion:
 - Show images or real samples of the Indigofera plant.
 - Explain its origins and how it has been used historically for dyeing fabrics and for medicinal purposes.
 - Discuss the cultural significance of indigo dye in different societies.
 - Activity:
 - Pass around samples of the Indigofera plant or indigo-dyed fabric.
 - Allow students to touch and observe the plant and fabric closely.
4. **Simple Chemistry of Dyeing (20-30 minutes)**
 - Explanation:
 - Introduce basic chemistry concepts: acids, bases, and chemical reactions.
 - Explain the process of extracting indigo dye from the plant (fermentation and oxidation).
 - Discuss how indigo dye binds to fabric fibers.
 - Demonstration:
 - Prepare a dye bath using natural indigo powder.
 - Dissolve the indigo powder in warm water.
 - Add a base (sodium hydroxide or washing soda) to make the solution alkaline.
 - Add a reducing agent to turn the indigo into its soluble form (leuco-indigo).
 - Activity:
 - Have students test the pH of the dye bath using pH strips and record their observations.
 - 3. Hands-On Dyeing Activity (30-40 minutes)
 - Preparation:
 - Divide students into small groups.
 - Provide each group with cotton fabric squares, gloves, and safety goggles.
 - Procedure:
 - Instruct students to dip their fabric squares into the dye bath.
 - Allow the fabric to soak for a few minutes, then remove it and expose it to air.
 - Observe the color change as the indigo oxidizes and turns blue.
 - Observation and Recording:
 - Have students note the initial color of the fabric, the color after dipping, and the final color after oxidation.
 - Discuss how the chemical process affects the color and texture of the fabric.

WEEK 6: INDIGOFERA PLANT STUDY

WEEK 7: SIMPLE CHEMISTRY OF DYEING - ACTIVITIES AND OBJECTIVES

. Conclusion and Discussion (15-20 minutes)

• Reflection:

- Ask students to share their observations and thoughts on the dyeing process.
- Discuss what they found surprising or interesting about the chemistry of dyeing.

• Wrap-Up:

- Summarize the key points learned about the Indigofera plant and the chemistry of dyeing.
- Encourage students to think about other natural dyes and their potential uses.



TEACHER NOTES: INDIGO DYEING

Materials Needed:

- Fresh or dried Indigofera plant leaves (or natural indigo powder)
- Sodium hydroxide (NaOH) or washing soda (sodium carbonate) as a base
- Reducing agent (e.g., sodium dithionite or thiourea dioxide)
- Cotton fabric squares
- Large glass jars or plastic containers
- Rubber gloves
- Safety goggles
- Measuring spoons and cups
- Warm water
- Stirring sticks or spoons
- pH strips (optional)
- Notebook and pencils for observations

Resources

WEEK 6: INDIGOFERA PLANT STUDY
WEEK 7: SIMPLE CHEMISTRY OF DYEING - ACTIVITIES AND OBJECTIVES

BOTANY LESSON

DISCUSS THE PARTS OF THE INDIGOFERA
PLANT AND SHOW REAL OR PICTORIAL
EXAMPLES.

leaf

stem

root

flower

seed



Resources

UNDERSTANDING THE CHEMISTRY BEHIND INDIGO DYEING

GRADE LEVEL: 6TH, 7TH GRADE, 8TH

Objectives:

1. Understand Key Chemical Concepts:

- Learn about oxidation, reduction, and hydrogen bonding.
- Understand how these concepts apply to indigo dyeing.

2. Explore the Indigo Dyeing Process:

- Learn the steps involved in the indigo dyeing process.
- Understand the chemical changes that occur during dyeing.

3. Engage in Hands-On Activities:

- Conduct experiments to observe oxidation and reduction reactions.
- Dye fabric samples to see the practical application of these reactions.

• Introduction to Key Chemical Concepts (30 minutes)

- Discussion:
 - Oxidation: Explain that oxidation is a chemical reaction where a substance loses electrons. Provide simple examples, like rusting iron.
 - Reduction: Explain that reduction is a chemical reaction where a substance gains electrons. Use the example of removing oxygen from a compound.
 - Hydrogen Bonding: Describe hydrogen bonds as weak bonds between molecules, important in many biological processes.
- Illustration:
 - Use the whiteboard to draw and explain oxidation and reduction reactions.
 - Show diagrams of molecules involved in hydrogen bonding.

◦ 2. Exploring the Indigo Dyeing Process (20 minutes)

- Explanation:
 - Discuss the structure of indigo dye and how it is naturally insoluble in water.
 - Explain how indigo dye needs to be reduced to become soluble (leuco-indigo) and how it re-oxidizes to form the blue color on fabric.
- Steps Involved:
 - Preparation: Dissolving indigo in a solution using a base and a reducing agent.
 - Dyeing: Dipping fabric into the solution where the dye bonds with the fabric fibers.
 - Oxidation: Exposing the dyed fabric to air to allow oxidation and color change.

◦ 3. Hands-On Experiments (60 minutes)

- Experiment 1: Observing Oxidation and Reduction:
 - Materials: Hydrogen peroxide, a reducing agent, and a small piece of metal (e.g., iron nail).
 - Procedure:
 - Submerge the metal in hydrogen peroxide to observe the oxidation reaction (bubbles form as oxygen is released).
 - Introduce the reducing agent and observe any changes.
 - Discussion: Discuss how electrons are transferred in these reactions.

UNDERSTANDING THE CHEMISTRY BEHIND INDIGO DYEING

GRADE LEVEL: 6TH, 7TH GRADE, 8TH

Objectives: Students will learn the chemistry of the indigo dyeing process which involves dipping fabric into a dye bath that is yellow-green color and leaving it under the surface for 5-10 minutes

Experiment Indigo Dyeing:

1. **Preparation:**
2. **Mix indigo powder with warm water in a container.**
3. **Add sodium hydroxide and washing soda to make the solution alkaline.**
4. **Add a reducing agent to the solution.**
5. **Check the pH with pH strips and adjust if necessary.**
6. **Dyeing Procedure:**
7. **Have students wear gloves and safety goggles.**
8. **Dip cotton fabric squares into the dye bath.**
9. **Allow the fabric to soak for a few minutes.**
10. **Remove the fabric and expose it to air, watching as it turns blue.**
11. **Observation:**
12. **Have students record the initial color, the color after dipping, and the final color after oxidation.**
14. **4. Conclusion and Discussion (20 minutes)**
15. **Reflection:**
16. **Ask students to share their observations and what they learned about the chemical processes.**
17. **Discuss why oxidation and reduction are important in indigo dyeing.**
18. **Wrap-Up:**
19. **Summarize the key points about the chemistry involved in dyeing with indigo.**
20. **Highlight the importance of understanding chemical reactions in real-world applications.**
21. **Assessment:**
22. **Participation in discussions and activities.**
23. **Observation notes and reflections are recorded in notebooks.**
24. **Ability to explain oxidation, reduction, and hydrogen bonding in the context of indigo dyeing.**
25. **Extensions:**
26. **Research Project: Have students investigate other natural dyes and the chemistry behind them.**
27. **Art Integration: Use the dyed fabrics in an art project, such as creating a piece of textile art.**

Materials Needed:

- Natural indigo powder
- Sodium hydroxide (NaOH) or washing soda (sodium carbonate)
- Reducing agent (e.g., sodium dithionite or thiourea dioxide)
- Cotton fabric squares
- Large glass jars or plastic containers
- Rubber gloves
- Safety goggles
- Measuring spoons and cups
- Warm water
- Stirring sticks or spoons
- pH strips
- Hydrogen peroxide (optional)
- Notebook and pencils for observations
- Whiteboard and markers

Resources:

Video

Video blue jeans Video of blue jeans: The ACS Reactions video "How Do Jeans Get Blue?" (3:06) is a quick history of jeans and the chemistry of indigo. This video is targeted to students.

COLLABORATIVE INDIGO ART PROJECT - JAPANESE TSUTSUGAKI AIZOME

Objectives:

1. **Understand Japanese Resist Dyeing (Tsutsugaki):**
 - Learn about the history and cultural significance of Tsutsugaki.
 - Understand the basic techniques and materials used in Tsutsugaki.
2. **Develop Collaborative Skills:**
 - Work together to plan and create a Tsutsugaki-dyed fabric piece.
 - Practice effective communication, teamwork, and creative collaboration.
3. **Engage in Hands-On Dyeing:**
 - Design and execute a Tsutsugaki project as a group.
 - Reflect on the process and the cultural heritage of the craft.

Lesson Activities:

Introduction to Tsutsugaki (20 minutes)

Discussion:

- Explain the history and cultural significance of Tsutsugaki, a traditional Japanese resist-dyeing technique using indigo.
- Show examples of Tsutsugaki textiles and discuss common themes and motifs.
- **Visual Aids:**
 - Use images and videos to illustrate the Tsutsugaki process.
 - Highlight the tools and materials used, such as indigo dye, rice paste, and fabric.
- 2. Exploring Indigo Dyeing (20 minutes)

Explanation:

- Discuss the basics of indigo dyeing, including the preparation of the dye bath and the chemical reactions involved (oxidation and reduction).

Demonstration:

- Show how to prepare the indigo dye bath:
 - Dissolve indigo powder in warm water.
 - Add sodium hydroxide or washing soda to make the solution alkaline.
 - Add a reducing agent to turn the indigo into its soluble form (leuco-indigo).
 - Test the pH with pH strips and adjust if necessary.
- **Safety Note:**
 - Emphasize the importance of wearing gloves and safety goggles during the dyeing process.
- 3. Planning the Collaborative Art Project (30 minutes)
 - **Brainstorming Session:**
 - Discuss ideas for the collaborative Tsutsugaki project. Possible options include a large wall hanging or a group of connected panels.
 - Encourage students to think about themes, patterns, and the overall design.
 - **Design Phase:**
 - Divide students into small groups to sketch out their ideas.
 - Have each group present their ideas to the class and discuss how to combine them into a cohesive design.

COLLABORATIVE INDIGO ART PROJECT - JAPANESE TSUTSUGAKI AIZOME

- cohesive design.
- **Finalizing the Plan:**
 - Create a final design that incorporates elements from each group.
 - Assign specific sections or tasks to each group, ensuring that everyone has a role.

4. Creating the Tsutsugaki-Dyed Fabric (60 minutes)

- **Preparation:**
 - Set up multiple dyeing stations with indigo dye baths.
 - Ensure all safety equipment (gloves and goggles) is available and worn by students.
 - Protect work surfaces with plastic sheets or table covers.
- **Design Transfer and Rice Paste Application:**
 - Transfer the final design onto the large piece of fabric.
 - Show students how to fill squeeze bottles or piping bags with rice paste.
 - Demonstrate how to apply the rice paste to the fabric to create their designs.
 - Allow students to apply their designs to their assigned sections of the fabric using the rice paste.
- **Dyeing Process:**
 - Once the rice paste designs are dry, have students dip their fabric piece into the indigo dye bath.
 - Allow the fabric to soak for a few minutes, then remove it and expose it to air to oxidize and develop the blue color.
 - Repeat the dipping and oxidation process if a darker shade of blue is desired.
- **Rinsing and Removing Rice Paste:**
 - After dyeing, rinse the fabric in water to remove excess dye.
 - Gently wash the fabric to remove the rice paste, revealing the white designs against the indigo background.
 - Hang the fabric to dry on clotheslines or drying racks.

5. Reflection and Discussion (20 minutes)

- **Discussion:**
 - Ask students to share their experiences and thoughts on the Tsutsugaki process.
 - Discuss the challenges they faced and how they overcame them.
- **Show and Tell:**
 - Have students present their finished Tsutsugaki piece to the class.
 - Encourage them to explain their design choices and what they learned from the project.
- **Cultural Reflection:**
 - Reflect on the importance of preserving traditional crafts and the role of cultural heritage in modern art.

Assessment:

- Participation in discussions and activities.
- Contribution to the planning and execution of the collaborative project.
- Reflection notes on the process and cultural significance.

Extensions:

- **Research Project:** Have students research other traditional Japanese arts and crafts and present their findings.
- **Exhibition:** Organize a display of the Tsutsugaki piece in the school to share the students' work with the larger community.

COLLABORATIVE INDIGO ART PROJECT - JAPANESE TSUTSUGAKI AIZOME

1



What is Tsutsugaki?

Paste made from steamed glutinous rice is used as a resist paste (Shamo mori). At Nagao's dye house they use glutinous rice only, and it takes one to two weeks to produce the paste. The paste is then set in a tatsu funnel that has been treated with fermented persimmon tannin (kashibu).

2

Drawing the designs with paste

The beautiful white resist lines of tsutsugaki are basically determined during the process of applying the paste. However carefully the fabric is dyed, if the paste application is poor, the dye will seep into the resisted area.



3



Covering with Bran to Solidify the Paste

Once the lines are drawn to some extent, before the paste dries, rice bran (nuka) is sprinkled over them to harden them. When the entire design is drawn, then water is applied with a brush from the back. This induces the moisture in the paste to penetrate into the cloth to create crisp, clear outlines.

4



Preparation for Dyeing Indigo

Just before dyeing in indigo, the fabric is brushed with lukewarm water to make the fabric absorb the dye more.

Materials Needed:

- Natural indigo powder
- Sodium hydroxide (NaOH) or washing soda (sodium carbonate)
- Reducing agent (e.g., sodium dithionite or thiourea dioxide)
- Large piece of cotton fabric for the collaborative project
- Large glass jars or plastic containers
- Rubber gloves
- Safety goggles
- Measuring spoons and cups
- Warm water
- Stirring sticks or spoons
- pH strips
- Rice paste (made from rice flour and water)
- Squeeze bottles or piping bags for rice paste application
- Paintbrushes
- Sketch paper and pencils
- Notebooks and pencils for observations and reflections
- Plastic sheets or table covers to protect surfaces
- Clotheslines or drying racks

5

Indigo Dyeing

The indigo vat is fermented for two to three weeks. If the fabric is dipped into the vat quickly, the indigo will not be absorbed, so it is slipped into the vat quite slowly. In the end the fabric is immersed in the bath from 10 to 12 times.



Credits/ Resources: <https://artsandculture.google.com/story/tsutsugaki-aizome/fQWxvaCUwbbLA>
<https://g.co/arts/Ing4ADkqWnHnbnYfb>
<https://g.co/arts/Z80aJAiB3H8ESKBib>
<https://artsandculture.google.com/story/tsutsugaki-aizome/fQWxvaCUwbbLA>

HISTORICAL AND CULTURAL IMPACT OF INDIGO



Ancient Origins:

- Indigo dyeing dates back to at least 5,000 years ago, with evidence of its use in ancient civilizations such as Egypt, Mesopotamia, and India.
- In ancient Egypt, indigo was used in mummy wrappings and tomb paintings, symbolizing status and protection.

Asia and Africa:

- India was a major producer of indigo dye, with historical texts and artifacts indicating its use for textiles and trade.
 - The Indigofera plant, the source of indigo dye, grows in tropical and subtropical regions, particularly in India, Africa, and East Asia.
 - In Africa, indigo dyeing was practiced by various cultures, notably in West Africa, where intricate techniques and patterns were developed.
 - European Influence:
 - Indigo became highly prized in Europe during the Middle Ages and Renaissance, replacing the native woad plant due to its superior dyeing properties.
 - The trade routes established by the Portuguese, Dutch, and British significantly expanded the global market for indigo.
 - European colonial powers cultivated indigo plantations in their colonies, particularly in India and the Americas.
 - Industrial Revolution:
 - The 19th century saw the development of synthetic indigo by German chemist Adolf von Baeyer, reducing reliance on natural sources.
 - Synthetic indigo became widely used in the textile industry, particularly for dyeing denim for blue jeans.
- Indigo dyeing dates back to at least 5,000 years ago, with evidence of its use in ancient civilizations such as Egypt, Mesopotamia, and India. In ancient Egypt, indigo was used in mummy wrappings and tomb paintings, symbolizing status and protection. Asia and Africa: India was a major producer of indigo dye, with historical texts and artifacts indicating its use for textiles and trade. The Indigofera plant, the source of indigo dye, grows in tropical and subtropical regions, particularly in India, Africa, and East Asia. In Africa, indigo dyeing was practiced by various cultures, notably in West Africa, where intricate techniques and patterns were developed. European Influence: Indigo became highly prized in Europe during the Middle Ages and Renaissance, replacing the native woad plant due to its superior dyeing properties. The trade routes established by the Portuguese, Dutch, and British significantly expanded the global market for indigo. European colonial powers cultivated indigo plantations in their colonies, particularly in India and the Americas. Industrial Revolution: The 19th century saw the development of synthetic indigo by German chemist Adolf von Baeyer, reducing reliance on natural sources. Synthetic indigo became widely used in the textile industry, particularly for dyeing denim for blue jeans.

Credit: A Tsutsugaki Furoshiki

Credit/Resources

<https://artsandculture.google.com/story/tsutsugaki-aizome/fQWxuaCuvW6bLA>

MATERIALS LIST

1. For the projects you may use any of the following indigo materials. Pre-reduced and indigo dye kits are easier to mix.



Dharma trading Resources: Indigo Dye Kit
or
Pre reduced Indigo/ Sodium Hydrosulphite/ Soda
Ash Fixer
Instructions on how to use pre reduced indigo
or



Organic Indigo. Instructions on how to make Vat

- 1 part indigo
- 2 parts pickling lime (calcium hydroxide).
- 3 parts fruit sugar (fructose) - henna can also
be used
- A 1 quart Mason jar and lid



Buckets with lids and squeeze bottles and
cotton/natural fabrics, gloves



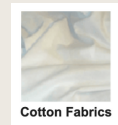
- Fabrics must be 100% natural cotton or muslin. You will need to scour the fabrics before dyeing. Use pH neutral, unscented laundry detergents such as Tide, or a soap such as Orvus Paste
- Cotton string, rubber bands, clothespins, dental floss, needles, thread, sticks, PVC pipes, measuring spoons, funnels, drop cloths
- Optional: Digital Scale, PH test paper

DHARMA TRADING

ORGANIC INDIGO. \$8.19
CALCIUM HYDROXYTE. \$4.35
FRUCTOSE GRANULES \$5.99

INDIGO DYE KIT. \$11.35

COTTON FABRIC. \$5.99 +
TIE DYE KITS FOR WHOLE CLASS \$72
DUST MASKS \$55 CLASS SET



Cotton Fabrics

AMAZON

GLOVES \$6.99
5-GALLON BUCKET \$6.99 EACH
RUBBER BANDS \$8.00 BAG
SQUEEZE BOTTLES \$1 EACH

S&MD

NEEDLES \$9
MUSLIN \$21
GLOVES \$8
SPONGES. \$5



OCEAN BANK CENTER FOR EDUCATIONAL MATERIALS
FACE MASKS-FREE

CHEAT SHEET

ORGANIC INDIGO RECIPE

PRE REDUCED INDIGO RECIPE

SHIBORI

Instructions on how to use RIT dyes to Tye Dye

INDIGO DYE FOR BEGINNERS

1 2 3 Fructose Vat

3 Types of Dye Vats

INDIGO

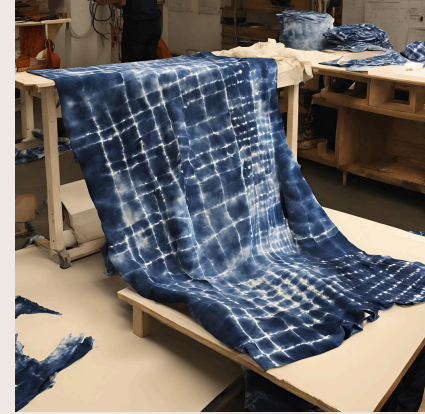
INDIGO IS A PIGMENT, NOT A DYE, MEANING IT DOESN'T NATURALLY BOND WITH FIBERS. TO MAKE IT SOLUBLE, YOU NEED TO ADD A REDUCING AGENT LIKE SODIUM HYDROSULFITE. THE APPLICATION PROCESS IS AKIN TO PAINTING, DONE LAYER BY LAYER. HERE'S HOW IT WORKS: FIRST, YOU DIP THE TEXTILE INTO A YELLOW INDIGO VAT, THEN EXPOSE IT TO AIR. THIS EXPOSURE CHANGES THE COLOR FROM YELLOW TO BLUE. YOU REPEAT THIS DIP-AND-FIX CYCLE UP TO 12 TIMES, DEPENDING ON THE DESIRED DEPTH OF BLUE. THIS METHOD DEPOSITS MICROSCOPIC PIGMENT PARTICLES ON THE TEXTILE'S SURFACE, UNLIKE TYPICAL DYES THAT PENETRATE THROUGH THE FIBERS.

SAFETY WARNING

- WEAR PROTECTIVE GLOVES, CLOTHING, AND EYE PROTECTION.
- WASH HANDS THOROUGHLY AFTER HANDLING.
- USE ONLY IN A HOOD OR WELL-VENTILATED AREA.
- INDIGO WILL STAIN SKIN, CLOTHING, AND SURFACES.

CLASSROOM SETUP

CREATE WORKSTATIONS FOR DYEING AND RINSING FABRICS TO ENSURE AN ORGANIZED AND EFFICIENT PROCESS.



Resources

GLOSSARY

[Full Glossary with pictures](#)

Alkaline

An aqueous solution with a pH higher than 7.

Añil is indigo's Spanish

ARASHI SHIBORI

Also referred to as pole wrapping shibori, Arashi utilizes wooden or copper poles to twist, wrap and then bind the cloth with thread before dyeing. Arashi is the Japanese word for "storm" and the resulting patterns are made up of irregular diagonal lines that are meant to resemble heavy winds or stormy seas.

KUMO SHIBORI

This technique involves gathering, pleating, and binding the cloth. This method is mostly used to create spider web patterns similar to Western tie-dyes.

Oxidation

Oxidation occurs when you remove your fabric from the indigo vat. Oxygen in the air reinforces the bond of indigo to your fabric. You can watch oxidation occur as the fabric turns green to blue within minutes.

ring dyeing," dip a textile in the yellow indigo vat, expose it to the air so it turns from yellow to blue, and then dip and fix it again, up to 12 times depending on the depth of blue you want.

RESIST DYEING

Resist dyeing is a method of dyeing textiles with patterns. Methods are used to prevent the dye from reaching all the cloth. The most common resists are wax (as in batik), tying (as in tie-dyes), or a combination of tying and stitching.

Shibori is a Japanese manual resist dyeing technique of tie-dyeing.

TIE-DYEING

The iconoclastic peace activist Ken Kesey and his Merry Pranksters claimed to have invented tie-dye in 1964 by taking LSD beside a pond and pouring enamel-based model airplane paint into it before placing a white tee on the surface of the water.

pH

A measure of acidity or alkalinity. A pH scale ranges from 1 to 14, with 7 as the neutral value. A pH below 7 indicates acidity which increases as the number decreases, 1 being the most acidic and 14 being the most alkaline.

Reducing agent

A chemical whose function is to remove oxygen from the indigo vat. Without reduction, the indigo vat will not work properly. Common reducing agents are henna, fructose, and ferrous sulfate.

Reduced

When the oxygen is removed from the indigo vat using a reducing agent, the indigo dye becomes soluble in water and can bond to the fabric.

RESOURCE LIST

Resources:

- [Smithsonian https://g.co/arts/5PNeHoYQMrC2xQJd6chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://fibershed.org/wp-content/uploads/2018/04/Indigo-sources-processes-possibilities-nov2017-revised.pdf](https://g.co/arts/5PNeHoYQMrC2xQJd6chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://fibershed.org/wp-content/uploads/2018/04/Indigo-sources-processes-possibilities-nov2017-revised.pdf)
- <https://createartwithme.com/adire-eleko-cloth-senufo-animal-art-lesson-part-1/>
- https://artsandculture.google.com/story/adire-the-art-of-tie-and-dye-pan-atlantic-university/_QVxsVP8AxQtIw?hl=en
- <https://www.vam.ac.uk/articles/adire-tied-and-dyed-indigo-textiles>
- <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://uwispace.sta.uwi.edu/server/api/core/bitstreams/81dd4583-75ee-4552-9ffa-a11d4ed8a4de/content>
- <https://www.youtube.com/watch?v=kyXpkiMir3o> (Katazome_
- <https://youtu.be/kiMBFKwnxzI?si=STbmZYWsCpOGFMvg>
- <http://facweb.cs.depaul.edu/sgrais/indigo.htm>.

The University of Minnesota Web site article "Indigo in the Early Modern World" briefly describes the history of indigo from about 2500 B.C. through the 1700s. (<https://www.lib.umn.edu/bell/tradeproducts/indigo>).

https://artsandculture.google.com/story/himalayan-indigo-avani-society/8gXRLe6_idGrLQ?hl=en

How Indigo is made

<https://youtu.be/hes05oYzd6c?si=tVgb2xf-NmvNSwjE>

Michael Garcia History of Indigo https://youtu.be/uduwbq1gWo?si=_1upBNLqzSNtLEGb

https://artsandculture.google.com/story/himalayan-indigo-avani-society/8gXRLe6_idGrLQ?hl=en

(<https://www.khanacademy.org/science/biology/chemistry--of-life/chemical-bonds-and-reactions/v/intermolecular-forces-and-molecular-bonds>).

<https://www.thecrucible.org/guides/indigo-dyeing/#2nd>

Books

My indigo world : a true story of the color blue, Chang, Rosa Sung Ji

<https://youtu.be/h7bRpDmLnCA?si=6wAWjCgVIM-JLpgZ>. Blue

Resources

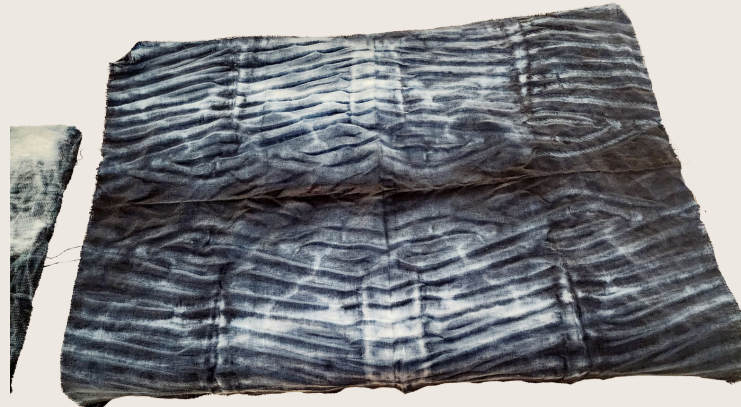
GALLERY



Student from Robert Renick dyeing with Indigo



Student from Neva King Cooper dyeing with Indigo



Student Sample



Resources