Adapted to STEMAZing ECE Format by
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Paper Marbling

<u>NOTE: Children should always be given ample time to experiment, notice, and wonder before they are provided an explanation.</u>

Always engage children with our two favorite questions:

What do you notice?

What do you wonder?

Resist the urge to answer any questions children have while exploring. Instead, respond back with questions to children and let them make sense of the world. Sample questions you might use: What do you think? Do you notice any patterns? What could we change? Can we test something else? What can we try next? If children ask a testable question, which they could answer by doing an experiment, talk through with th how they might design a test to help answer their question. As much as possible and within reason, let them test their questions by trying the experiments they propose.

Learning Objectives

Children will…

- experiment with the art of paper marbling.

Key Question

What will happen if we add food coloring to shaving cream?

Vocabulary (See **What the heck? Explanation of Science** at the end for definitions.)

surfactant
hydrophilic
hydrophobic

Materials

Two large plates
Shaving cream (foamy not gel)
Liquid food coloring (at least two different colors)
White printer paper or cardstock paper
Dropper or Pipette
Scissors
Spoon
Toothpick
Jumbo craft stick
Paper towels
Spray bottle
Water

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Notice and Wonder Developmentally Appropriate Practice

1. Place the two plates next to each other on a workspace that can tolerate shaving cream spills.
2. Cut two letter-sized pieces of paper in half crosswise. Then fold each in half, creating four cards.
3. Put water in the spray bottle and set it aside.
4. Put shaving cream on the two plates and spread it out with your hands or a spoon to create a layer with an area at least as large as your paper card and a depth of about half an inch thick.
5. Take the first color of your food coloring and add several drops on top of the shaving cream using either an eye dropper/pipette or dripping it straight from the bottle. Do this with both plates.
    - What do you notice?
6. Repeat step two with all other food colors that you want to use.
7. Next, take the toothpick and carefully swirl around the color in the shaving cream until you have created a color pattern that you like. Try not to overmix the colors.
    - What do you notice?
8. Use the spray bottle to spray some water on top of the color pattern on one of the plates. Use at least 5-10 pumps of water. Then let the foam sit for about one minute.
9. Finally, place your first card with the front side facing down on top of the shaving cream and press it lightly so that the whole card is covered by the shaving cream.
10. Repeat step six with the second card and the second plate.
11. Carefully remove both cards from the shaving cream, turn them around and scrape the remaining shaving cream from the card's surface with a craft stick or remove it with a paper towel.
12. Let the cards dry. If the paper wrinkles, an adult can iron it with an iron on the lowest heat setting and another sheet of paper between the card and the iron.

Children should notice…

- the food coloring does not mix with the shaving cream.

Differentiating Developmentally Appropriate Practice

Younger Children – Use pie pans instead of plates to contain shaving cream.

Older Children – Give older children different types of liquid to experiment with on their own.

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Extensions for Additional Learning

As always, ask the children throughout the experiment what they notice and what they wonder. If their wonder questions are testable, as much as possible and within reason, let them test their questions by trying new experiments.

See below for examples of what they might wonder and experiments they might do to test their wonderings.

- I wonder how many different swirl patterns you can create?
  - Let them try it!
- I wonder what happens if you spray oil or rubbing alcohol instead of water on top of your color pattern? Will your results differ?
  - Let them try it!
- I wonder what happens if we use different size paper?
  - Let them try it!

#STEMAZingPictureBook Recommendation: *Water Marbling Patterns: Paper Airplanes* by Lovable Duck Paper

Connections to the activity:

Make paper airplanes out of marbled paper.

References

https://www.sciencebuddies.org/stem-activities/paper-marbling?from=Blog#exploremore

SAFETY CONCERNS

n/a

AZ Early Learning Standards

Science Standard - Strand 1: Inquiry & Application - Concept 1: Exploration, Observation & Hypotheses
The child observes, explore, and interacts with materials, others, and the environment.

Science Standard - Strand 1: Inquiry & Application - Concept 2: Investigation
The child researches their own predictions and the ideas of others through active exploration and experimentation.

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What the heck? Explanation of the Science (Vocabulary in bold.)

The shaving cream marbling method works very similarly to the other paper marbling techniques methods described below. Shaving cream is made of a mixture of soap and water with a gas that can turn liquid into foam when you spray it out of the bottle. Soap is a **surfactant**, which means its molecule has a **hydrophilic** (water loving) and **hydrophobic** (water repelling) end. Liquid food coloring is a mixture of dye in water or alcohol, and therefore is hydrophilic. When you drop the food coloring on the shaving cream, it won't get soaked in, as it can only interact with the hydrophilic parts of the soap molecules and is repelled by the hydrophobic parts. Even if you swirl the colors with a toothpick, you still see a distinct separation between the color and the shaving cream.

When you put the paper on top of the color pattern, the food dye gets soaked into the paper, transferring the whole pattern onto its surface. This is because paper is made from wood pulp, which mainly consists of cellulose found in cell walls of green plants: a hydrophilic molecule. The hydrophilic food dye can spread easily across the paper, creating a marbled pattern. However, when you spray water on top of your pattern before you put the paper on top, the food dye mixes with the water and is carried into the deeper layers of the foam. You might have noticed that your color pattern looked washed out after adding the water. The pattern on the paper does look much lighter than the other one—but is it just as beautiful!

What the heck? Explanation of Science

Paper marbling is an artistic method in which colors floating on a liquid surface are transferred onto paper to create a marbled pattern. The art of paper marbling dates back to the 10th century where Japanese artists developed a technique called "suminagashi," which means "floating ink." Oil-based ink is dropped into a shallow pan of water where it floats on the surface. Next, paper is laid on top of the floating ink and the color transfers to the paper's surface.

Another paper marbling method that originated in Turkey and Central Asia involves a thick liquid, called size, made from substances such as carrageenan or cornstarch. In this method, the liquid has to be thickened as the colors used are water-based and would otherwise not float. To make the colors float and spread even better, they are mixed with surfactants then dropped onto the size, which results in a pattern of floating color that can similarly be transferred onto paper.

Although they might not have known it then, this art technique involves a lot of science! The colors float because they are less dense than water. It is also important that the colors and the water do not mix. Whether a liquid mixes with another depends on their individual molecular structures. The molecules that make up a liquid can be either polar or nonpolar. The simple rule "like dissolves like" says that polar substances dissolve in

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polar liquids and nonpolar substances dissolve in nonpolar liquids. Water is a polar substance while oil is nonpolar, which is why they don't mix.

Substances that dissolve in water are called hydrophilic and substances that do not are called hydrophobic. Surfactants are added to the colors because they influence their spreading behavior. Surfactants are special molecules that have a hydrophilic and a hydrophobic end, allowing them to spread out better by decreasing the surface tension of water. Surface tension holds the water molecules together at the surface as water molecules are slightly attracted to one another; at the water's surface, they are more attracted to the other molecules around them than to the air above. This forms a thin "skin" of strongly attracted water molecules that are difficult to break through.

Reference

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