Chemistry in Art: The Science of Dye

Madeleine Burland

Art Education, School of Art

Undergraduate Research Symposium Presentation

When I was first trying to develop this project, I wanted to find a way to teach both chemistry and art, and to combine the two in a lesson for the art classroom. I was considering a project that focused on the process of making paper for a long time, looking at the art of origami, but I ended up changing my mind after a batik class I took over the summer. Batik is a type of fabric art that uses wax as a resist so that only areas without wax on the fabric end up being dyed. And when I took this class, we had one day that focused on shibori, a Japanese resist technique involving sewing into the fabric, then tightening the stitches to create areas of resist on the fabric. The most interesting thing about this project was that we used natural materials to make dye instead of using synthetic dyes. This is where I found the inspiration for my project, because the science behind making dye, especially from natural materials is really interesting, and I thought a fabric arts lesson with a focus on experimentation and testing of different materials to create various dyes would make an engaging multidisciplinary art lesson.

There were two main components that made up this project. The first being lesson plans written in EdTPA format, that planned out the lesson over a series of days. The second was test samples of a few different natural materials, and I have here the results of this experimentation. When choosing materials, I wanted to take into consideration the fact that a school may not have a very large budget to work with for art lessons, so I tried to limit the materials to inexpensive things that can be found at any typical grocery store. For dyes, I tested common fruits and vegetables; avocados, blueberries, celery, carrots, coffee, nothing too far out of the ordinary. For fabric, I used two different types of muslin, which are 100% cotton. All-natural fabric was necessary for this project, because the natural chemicals in plants won’t bond as well with synthetic materials like polyester.

In the process of trying to get a wide range of colors of dye, I tested a lot of materials, and some of them worked, while some had no result at all. I set up the experimentation portion of this project to test a number of variables that might affect the color of the dye. First, I used two different types of muslin, to see if a different fabric would result in brighter or different colors. I also tested the impact of a mordant (a substance, typically an inorganic oxide, that combines with a dye or stain and thereby fixes it in a material) on the dye, to see if having it was important to helping the dyes hold. From the test samples, I found that neither the difference in fabrics nor the use of mordant had any effect, however some dyes aren’t wash-fast or even light-fast, meaning they’ll fade with washing or just exposure to light, and so the mordant might prove to have an effect later on.

Of the ones I tested, I found that coffee, avocado pits, blueberries, pomegranate seeds, black beans, paprika, and basil, worked fairly well, however I saw no results from celery, artichokes, carrots, or lemons. In the cases of the four that didn’t work, the initial color of the dye bath was lighter than those that did work, suggesting that there aren’t as many colorants in these vegetables that would be able to bond to the fabric. It’s also possible that I didn’t prepare the dye or fabric in the best way to produce a bright color. Much of the dye I was able to make came just from boiling the natural materials, but the literature of producing dye comes mostly from DIY sites, and so there are conflicting instructions on what will work for different plants.

The avocado pits I found to be the most interesting and surprising, primarily because the color dye they produce is a light red, which was unexpected based on the color of avocados. As shown in the pictures of the process, I made the dye first by heating a pot of water to boiling. I then added three pits to the water, lowering the temperature to a simmer. The longer the pits were in the water, the darker the water became as it pulled the colorants out of the pits. The pits themselves also changed, the hard, outer layers beginning to open, which may have helped increase the concentration of dye. After about 40 minutes of simmering, I let the dye cool, then added the fabric. I found out later that a good step to include is to strain the dye and remove the natural materials so they don’t get on the fabric, but it didn’t seem to affect the fabric much. The dye worked almost right away, but with the avocados and most of the other dyes, the longer the fabric remained in the dye, the stronger the color became. This was especially true for the blueberries, which became very dark after 18 hours in the dye. Blueberries also worked well as a dye, and not only changed dramatically with time, but I was able to get a completely different shade of purple from them by using old berries.

Along with testing plain squares of fabric, I also tested a couple shibori techniques, stitching lines and shapes in the fabric, and using cardboard shapes and rubber bands as a resist to create samples of a few basic techniques. I found that for the stitching, a simpler pattern worked better, and the areas of resist were stronger if the fabric wasn’t in the dye for very long. However, the cardboard was able to stay in longer without the dye filling in the areas of resist. I included pictures of the silk I used in my summer batik class. In general silk seemed to hold the patterns better than the cotton, but because silk is much more expensive, it’d be unlikely that it could be used in a classroom setting, and the cotton works well enough.

By performing all these tests and experiments, I feel that now I have a better understanding of the process of making and using these dyes, as well as some of the problems that might occur and how to solve them. From here, I think it would be feasible to incorporate this project into the classroom, and use it as a way to teach not just shibori and fabric arts, but chemistry, experimentation, and the scientific method. While I was doing the tests, I found myself changing procedures, and trying different things to try and get a color from the fruits and vegetables, and in some cases I was successful and in others I wasn’t. In teaching this lesson, my hope is that students will be able to go through the same process I did, by finding and testing vegetables and plants other than the ones I used, using my samples as a guide for what may work instead of a rulebook of what materials will and won’t work, and I think making experimentation instead of success the goal for my students will be my biggest challenge in teaching the lesson, because it is disappointing when the dyes don’t work, or don’t turn out how they were supposed to.

Although I was unable to get a full rainbow of colors out of the testing process like I’d hoped, I feel like the colors I did get, as well as the ones I didn’t get are a good foundation for when I teach the lesson in the future, and for my students to consider when planning their projects. I have by no means learned everything there is to learn about the process of dyeing and natural dyes, but the fact that there’s so much to the subject will make it better to teach and give my students more creative freedom and room for experimentation, which was the primary goal I had for this lesson and this project.