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How To Dye Cloth

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Ever since clothes were developed people have found ways to enhance their own appearances and express beauty by adorning or decorating their garments. Painting, dyeing, stitching, and attaching ornaments are just some of the ways people have decorated clothes. Today many individuals still think of clothes as more than just body coverings. The clothes people wear show that they are concerned with appearance and the expression of beauty.

The techniques, or methods, for decorating clothes developed many centuries ago, were hand methods. Some are still done by hand today, although many have been modified, or changed, to be done by machine. Other techniques once used to decorate clothes are no longer in use today. However, many museums have collections showing examples of these and other ways people have decorated clothes.

Painting with dyes made from natural materials made in the environment has been done for thousands of years. The Polynesians painted designs on tapa cloth, or bark cloth, made from the paper mulberry tree. Indians who lived in the plains regions in North America painted animal skins that they prepared for clothing. Today people still do hand painting on fabric, but machine methods of painting designs and colors are used for producing large quantities of fabrics.

Therefore, my challenge as an educator would be to arrange and implement a student library of learning experiences which will allow all students to begin an appreciation for the complexity of dyeing cloth in the area of Home Economics.

My unit, *How To Dye Cloth* , is an attempt to instruct and orchestrate a challenge in the area of Home Economics. It is being designed for usage among sixth, seventh, and eighth grades. The curriculum unit consists of four main areas of concentration: the History of Dyes, The Types of Dyes and the Natural Dyes; How Dye is Applied to Fabric; Suggested Teaching Strategies, along with specific classroom activities; and finally, a list of resources for both the student and teacher.

This unit is being designed primarily to introduce how cloth may be dyed. So often, the discipline of science is omitted in the classroom. A ready example of dye would be the red cabbage versus the white cabbage. Why do your hands turn red to reddish purple? This exposure will be looked at in the form of cloth. Everyone puts on a variety of colors. They may or may not know how the cloth was prepared. Therefore, throughout this unit, we as educators will explore the cloth and the application of color in the creation of a new look.

This unit is designed to be used over a ten to fifteen week period. Students will be encouraged to examine the complexity and interaction between technology and society. The activities suggested may be carried out in a variety of ways. Individual and group work, class discussions and demonstrations will be teacher led activities through discussions and visual presentations.

The primary goals and objectives of this unit are the following:

To emphasize the importance of society and technology as a root for modern science.

To provide teachers with relevant, current curriculum materials which can be infused into their home economics curriculum.

To use the excitement of clothing industry as a catalyst for our youth in the area of science.

To use student achievement in reading and comprehension activities in the home economics curriculum.

To provide relevant material and information for the student's achievements.

History of Dyes

Until the mid-19th century, all dyes were derived from the leaves, twigs, roots, berries, or flowers of various plants or from animal substances. Tyrian purple, used by the Phoenicians in the 15th century BC, was produced from certain varieties of crushed sea snails. The use of indigo as long ago as 3,000 BC has been documented; synthetic indigocis still an important dye because it is exceptionally fast.

The textile dyeing industry in Europe originated in the 16th century. when the Portuguese, Dutch, and English introduced indigo. Natural dyes such as Cochineal, Turmeic, Wood, Madder, and Henna remained the primary source of dye colors until the discovery of the first synthetic dye in 1856 by Sir William Henry Perkin.

Perkin, an English chemist, was working with the coal-tar derivative ANILINE when he accidentally discovered that a by product of aniline oxidation had dyeing capabilities. He established a factory to manufacture his new purple dye, mauve; other experiments began to produce new colors from aniline and other coal-tar derivatives. Alizarin was the first natural dye to be produced synthetically, (1868), and by 1880 indigo had been synthesized. By 1916, an extensive technology had developed, most of it concentrated within a German cartel that held a virtual monopoly over dye production. Only with the onset of World War II did Germany lose its position as the world's principal supplier of dyes. Today, the U.S. dye industry, aided by the post-World War II acquisition of German technology, has become a major exporter of dyes.

By 1881 Perkin had synthesized glycocoll, cinnamic, courmarin, and several unsaturated acids. In 1878. this latter work resulted in the "Perkin synthesis," the preparation of unsaturated acids by the condensation of an aromatic aldehyde with the salt of a fatty acid. The synthesis of coumarin was of special importance, being the first vegetable perfume ever produced from coal-tar, Perkin also undertook a comprehensive study of optical isomerism. From 1881 to the end of his life he devoted himself to a study of magnetic rotation, a tool to prove invaluable in determining organic structures.

Mordants are chemical substances formerly used to confer affinity for textile fibers to natural and early synthetic dyes. Alizarin, applied with an aluminum-salt mordant, was used extensively to produce bright red shades on cotton. Tannin and sodium stannate were used to form insoluble salts with basic dyes on silk. Chromium still is used to a limited extent in the United States, and to a greater extent abroad, with azo and basic dyes for the dyeing of wool and the printing of cotton. Chemically the quantity of a substance having the weight in grams numerically equal to its modular weight refers to mole. A mole of a substance contains 6.02257×10^{23} molecules. Given this formula, the types of dyes can be clearly discussed in the following section.

Types of Dyes

Dyes may be classified according to their manner of application, the fibers for which they are used, or their chemical structure. Almost all dyes, however, fall into one of the following categories:

Vat dyes are extremely fast dyes applied particularly to cotton. The water-insoluble dye is reduced in a vat to a water-soluble compound. After the fabric is dyed, it is exposed to air or to a chemical oxidizing agent, and the dye reverts to its insoluble form.

Sulfur dyes, used to produce deep shades on cotton, are inexpensive dyes made by the reaction of various organic chemicals with sulfur or sodium sulfide.

Direct dyes are azoic dyes to which common salt or sodium sulfate has been added; they can be applied directly to cotton or other cellulosic fibers such as flax, jute, or paper, without pretreatment of the fiber with a mordant.

Acid dyes are used for wool, silk, and some synthetics. Unlike the vat and sulfur dyes, they are water-soluble and can be applied directly to the fiber.

Disperse dyes soluble in acetate but not water, are used to dye polyester, polyamides, and other synthetic fibers.

Basic dyes include most of the first synthetic dyes. They are cationic (that is, they have a positive electrical charge) and are used for anionic (negative-charge-bearing) fabrics such as wool, silk, nylon, and acrylics. They are particularly brilliant, and most fluorescent dyes are basics.

Metal-complex dyes, used primarily on wool, are combinations of a dyestuff and a metal, usually chrome. In use since the 1940’s, they were developed from the older mordant dyes and are highly light-and wash-fast.

Reactive dyes, the newest dye class, function in an entirely different manner from other dyes. Ordinary dyes adhere to their substrate; reactive dyes become a part of the substrate molecule (and they are, therefore, exceptionally fast). The most important in this group are the azo dyes, a group of organic compounds whose dyeing properties are based on their linkage by a nitrogen, or azo bond. Thousands of azo types have been developed for use on every type of fiber. Azoic dyes are azo types developed specifically for cellulose fibers.

Azo Dyes. The next major breakthrough came with the utilization of the diazo reaction in the formation of synthetic dyes. The diazo reaction had been discovered by the German chemist Peter Griers in 1858, when he Observed that aromatic amenities (R.NH2) could be readily converted to diazonlum compounds (R.N=N.C1) under appropriate conditions.

Some azo dyes are used with mordants. In this case, chelating metals are used with the dyes to achieve both light-and wet-fastness. Without the chelating group the azo group is open to photochemical attack and the chromogen can be destroyed. This possibility can be reduced considerably by incorporating a chelating system, usually the O-O’ dinydrcxy azo system, into the molecule to chelate a metal atom.

Natural Dyes

Although the natural dyes are of a chemical and historical interest, in most dyeing operations they have been almost completely replaced by synthetic colors, which are generally purer, less expensive, and more color fast. However, logwood, and turmeric, are still used to a limited extent. Of the three classes of natural dyes, plant dyes are by far the most numerous and mineral dyes the least numerous. The plant dyes are Obtained from the members of many different botanical families and from different parts of these plants.

Two of the most important plant dyes, indigo and madder (now called alizarin), are now produced from coal-tar and are valuable articles of commerce. The early use of indigo in widely dispersed areas have been proved by the unearthing of indigo-dyed fabrics from Egyptian’s tombs and from the graves of the Incas of Peru. This blue dyestuff was Obtained from the leaves of plants of the genus Indigofera, a species of which was cultivated in India thousands of years ago. Indigo was introduced in Europe in 1516. At first it competed with, but eventually it supplanted, another blue plant dye that was obtained from wood, which was probably the earliest plant to be grown solely for its pigment content.

Alizarin is the active ingredient of the famous Turkey red dye, which for centuries was the fastest and most brilliant red dye known. Alizarin was Obtained from the madder plant, Rubia tinctorum, which was formerly cultivated extensively in France, Belgium, and Turkey. After the synthesis of alizarin in 1868, the production of the natural dye decreased rapidly, eventually ceasing altogether.

Probably the most famous, and surely the most expensive dye of ancient times was Tyrian purple, an animal dye. It was Obtained from a small sac in the body of a snail-like marine mollusk, Murex brandaris, found along the shores of the eastern Mediterranean. Each mollusk shell had to be broken individually, and each small sac of 3,880,000 mollusks were require to make a single pound of the dyestuff. Only royalty and the very wealthy, therefore, could afford to wear apparel colored with this dye, hence the expression “born to the purple.”

(figure available in print form)

Lesson Plan

Name : Dyeing Cloth

Subject *: Home Economics*

Instructional Level : 8th graders *Grade Level* :

Objectives : To identify the type of cloths which man be dyed. To illustrate the techniques and equipment to be used.

Procedures : Dip the entire garment in dye. Let drip, then ring out excess liquid. This makes it one solid color. You can buy dyes at most grocery stores.

Materials :

Water Dryer
Dye Item to be dyed
News paper

APPLICATION OF Dyes

Preparation of Fibers. Most fibers require some preliminary treatment before they are dyed. Wool, for example, requires thorough scouring with soap and soap ash to remove dirt and grease. Sometimes the vegetable impurities in wool are removed by immersing the fiber in dilute sulfuric acid, drying it, and then heating it to 110°C. (230°F.). This is called carbonizing. Sometimes the wool is bleached or stoved (exposed to sulfur dioxide gas) prior to dyeing.

Raw cotton contains natural waxes and other noncellulosic impurities. These are generally removed by a process called kier boiling, which consists of boiling the cotton in a special autoclave, or kier, under pressure with a dilute solution of caustic soda, soap, or other alkali. Cotton threads are usually starched, or sized, to facilitate weaving; the starch must be removed before dyeing, and this is usually done by fermenting the starch in enzymes. Other processes that are often used on cotton before dyeing are bleaching with sodium hypochlorite and dilute acid and singeing to remove fine fuzzy projecting fibers.

Viscose rayon yarn, in the form of skeins, cakes, or loose yarn, seldom needs predyeing treatment. Woven or knit goods, however, are treated with a hot ammonical soap solution to remove the gelatin size. Acetate rayon is often scoured with soap and ammonia, and nylon rarely needs prelillnary treatment prior to dyeing.

Raw natural silk contains a gumy substance called sericin. Before the silk is dyed, the sericin is removed by a process called boiling off, or degumming, during which the fiber is heated in a dilute soap solution for two hours or more. Silk is sometimes weighted with tin salts to improve its luster and draping qualities.

Dye Operations And Machines . Although dyeing was formerly a hand operation, and still is in homes and laboratories, commercial operations are now performed almost entirely with machinery. Dyeing machines are of two main types, those in which the material to be dyed is moved through the dye solution and those in which the dye solution is circulated through the material. However, in some of the newer machines, there is movement of both the material and the dye solution.

There are three basic methods for moving the material through the dye solution. In one of these, hanks of the material to be dyed are fastened to a wheel, which rotates them through the solution. In another method, the material is drawn up and down over a series of rollers immersed in the solution. In a third method, cloth that is wound around one roller is passed into the solution, under a guide roller beneath the surface of the liquid, and then rewound on another roller. There are variations of each of these methods.

There are also several methods for circulating the dye solution through the material. In one of these, loose fibers are placed in perforated containers through which the solution can be circulated. In another method, hanks of yarn are fastened to a frame, which is then lowered into a tank through which the solution is circulated by propellers.

Union Dyeing. Unions are materials woven from two or more different kinds of fibers, such as cotton and wool or viscose and acetate rayon. One means of dyeing unions is to dye each kind of fiber separately with the appropriate kind of dye and then to weave the colored yarns into cloth. Excellent results are obtained by this method, but it is relatively expensive. Another process is to weave a dyed fiber with an undyed one and then complete the coloring operation by dyeing the cloth. The commonest and most economical method, however, is to dye the union in a bath containing the right mixture of dyes that will color all components of the mixed fabric to the desired shade. Because of the large number of fibers available, it is evident that choosing the correct dyes and dyeing conditions for coloring the many different kinds of unions now on the market requires the greatest technical skill on the part of the dyer.

(figure available in print form)

Textile Printing

Textile printing is of the greatest commercial importance. Essentially, it is the application of dyes to cloth in definite patterns.

Name : Stencil Dyeing

Instructional Level: Middle School

Grade Level : 6th & 7th grades

Objectives : To identify stencil dyeing. To enhance beauty to a garment.

Procedures : Design is created by putting color through a stencil. A stencil is a paper with patterns or letters cut out. The color passes through the cut out areas. This too requires special equipment and dyes.

Materials:

Stencil	Cloth	Paper clip
Paint	Brush	
Tape	Paper	

The printing of textiles has been practiced in India and China for countless centuries and is still in use to a limited extent. This process is similar in principle to ordinary letterpress printing, in which the raised portions of prepared blocks receive dye and then transfer it to the material to be printed. Attractive prints may be obtained by skilled workers, but the process is slow and not easily adapted to quantity production.

Stenciling is another method of applying colored patterns to cloth. A popular variant of this process. silkscreen printing, has long been practiced in Japan and is now much used in the United States by artists, and to some extent by commercial firms, to achieve special effects. In this process the design is first traced on a silk screen, and the portions that will appear uncolored are lacquered. Dye paste is then rubbed over the surface of the screen and penetrates the unlacquered silk to give the desired pattern to the cloth beneath the screen. A separate screen is needed for each color.

(figure available in print form)

Attaching the Stencil

Before you start to stencil you must first ensure that all the edges of the design can be kept in close contact with the surface which you wish to stencil. This is to stop your paint from seeping under the edges and spoiling the clean outline of your design. The fine spray of spray paint, for example, will drift under the smallest part of a loosely attached edge, so great care must be taken at this stage. A beautifully designed stencil can easily be blurred and spoilt by hurrying.

I have found that the most effective way of attaching stencils is to use an aerosol adhesive, generally available in larger graphics and art supply shops, which coats the surface with a thin layer of light adhesive that remains tacky for some time. The stencil can therefore be stuck down and lifted off a surface a number of times without damage to that surface.

Place the stencil, reverse side up, on a sheet of newspaper and spray the glue thinly and evenly all over it. This process is easier if done against a vertical surface such as a door, since this prevents the nozzle clogging. Let it set for a few moments. When you are ready, position the stencil accurately, glued side down, on the surface you are to decorate.

Some people may prefer to attach the stencil with dress-making pins. They take more time, but are far cheaper and, perhaps, more readily at hand. Tap them in with a small hammer at intervals along the cut edge of the design. They should only be inserted to the point at which they will stand firmly without support and can be pulled out easily with your fingers. *Batik* is a dyeing process developed many centuries ago in the Indonesian island of Java. Batik dyeing is done by covering parts of cloth with wax before the cloth is dyed. The waxed areas do not absorb dye and leave a pattern of uncolored areas against a dyed background.

(figure available in print form)

Batik is still done in some areas of the world and by people who enjoy producing handcrafted products. The appearance of batik can be illtated by factory processes which produce thousands of yards of fabric rapidly. The batik-like fabric sold in fabric stores and used for ready to-wear garments has probably been produced by printing the design on the surface of the fabric in a factory process. Hand produced batik may be found in some specialty shops and import stores.

Ikat , or tie-dyeing, is another process using dye for decorating cloth. This art was developed in Japan and India more than a thousand years ago. To tie-dye, parts of cloth are folded and knotted or tied in such a way that the tied areas do not absorb dye when the cloth is put into the dye solution. When the tied areas are loosened they leave an uncolored pattern on the dyed background.

Many fabrics today which appear to be tie-dyed are made by machine. However, like the batik process, tie-dyeing by hand is still done today. The Yorubas of Nigeria are skilled in ornamenting cloth with individualized patterns using the tie-dyeing process. You may have tried tie-dyeing or may know someone who decorates fabric in this way.

In tyanting dyeing the cloth is elaborately washed and soaked to secure the right texture and surface and is then hung over a frame, the artist, usually a woman, sitting cross-legged before it. The design is sometimes first sketched in charcoal, but the heat artists use only their tyantings, relying on visual memory. They outline the area that is to be dyed and cover the rest of the surface with wax. The cloth is then immersed in cold water till the wax hardens and is afterward dipped in the dye vat. The wax is removed, leaving exposed other parts of the cloth to be dyed different colors by the same process. The traditional colors are indigo blue, madder red and brown; secondary colors are produced by dyeing one color over another.

The origin of block printing on textiles is somewhat Obscure but it is clear that the printing of textiles by means of blocks was developed from free-hand painting with a brush. Wooden blocks believed to have been used for textile printing have been found in burying grounds at Akhmim, upper Egypt, and are said to date from the 4th century A.D. No textiles printed by means of these blocks have, however, been found. In Europe, block printing of fabrics does not appear to have begun much before the end of the l2th century A.D.; the chief center appears to have been the Rhineland of Germany.

In blocks used for printing, the spaces between the lines or devices forming the pattern were cut away, leaving the design standing in relief, as in letter-press printing. The color was then applied to the surface of the block and the colored block pressed down on the cloth. The pigments were mixed with starch, gum (tragacanth) or a mixture of these, or even with varnish, so that the color was in a viscous state and did not run from the raised portions of the block. Cennini describes how the outlines of the patterns were printed by block and additional colors added by means of a brush.

One of the clearest expositions of block printing in the “madder style” is given in the supplement to John Barrow’s *New and Universal Dictionary of Arts and Science* . The cotton or linen was printed with chemical substances known as mondants, which on immersion in the vat reacted with the soluble dye to precipitate an insoluble coloring on the cloth fibers so that the color remained permanently fixed in the mondant-printed areas while the dye taken up by the unmordanted parts could be easily removed by washing. In madder dyeing, different mordants can produce various shades of reds, pinks, purples and browns from a single immersion in the dye. The different mondants were printed one by one, the printer moved along the whole length of the cloth printing the first mordant from one wood block, then the second mordant from another block, and so on, until the whole pattern was completed. The mordant-printed cloth was then immersed in the dye. The reds, browns and purples were produced by printing varying strengths of alum and eron mordants, followed by immersion in the madder dye. Yellows and drabs (light, brownish colors) were produced by the printing of similar mondants followed by dyeing with weld, also known as dyer’s weed. Blue was produced by “penciling-in” indigo with a brush. This operation was usually carried out by women or girls. All greens were produced by the penciling-in of indigo over yellow. To save expense, the yellows were often blocked or painted in to avoid an additional dyeing but with this method the yellow dye was fugitive and in many extant l8th century textiles the yellow has almost entirely disappeared.

Lesson Plan

Name: Tie-Dyeing

Subject:

Instructional Level :

Grade Level: Learning Center Main Streamed Students

Objectives (3) : To illustrate variety in design and color. To create a different pattern. To identify the colors on the color wheel.

Procedures : Tie-Dye To apply bands of color to fabric products such as T-shirts or wall hangings. This is easy and costs little to do.

Materials :

T-shirt	Muslin
Dye	Drying rack

Rubber bands

Alternative Strategies :

Appendix A

Selected Natural Dyes

Name	Color	Source	Used On	Class
Annotto	Orange-red	Seeds of Plant	Cotton	Direct
Berberill	Yellow	Seeds of the Barberry shrub	Cotton, Leather, and Silk	Mordant
Brazilwood	Brick-red	From the tree	Cotton and Wool	Direct
Chrome Yellow	Yellow	From the mineral crocoite	Cotton	Direct
Rustic	Yellow-gold	Mulberry tree	Cotton and Wool	Mondant
Iron buff	Buff	Mineral containing iron sulfate	Cotton	Direct
Kermes	Scarlet	Insect	Cotton and Linen	Direct
Lac	Red	Insect	Cotton and Linen	Direct
Log wood	*Purple* *Blue to Black* Violet to Black	Heartwood of the tree	Wool, Cotton and Silk	Mondant
Turmeric	Yellow	Tubus of the herb	Cotton, Linen Silk, and Wool	Mordant

Appendix B

Classes of Dyes Used on Major Textile Fibers

Class Acetate Acid Azoic Basic Developed Direct Sulfur Vat Mordant

Fiber

Acetate P S S

Acrilon P S

Cotton P P P P P P

Dacron P S S

Dynel P S S S

Linen			S	P		P	P	P	
Nylon	P	P	S			S		S	
Orlon	P	S	S	S				S	S
Rayon	S	P	P	P	P	P	P		
Saran	P								
Silk		P	S	S	P	P		S	P
Wool		P				S		S	P

P: preferred use; S: secondary use

Appendix C

Chemical Classification of Synthetic Dyes

Class	Chromophore	Approximate Number of Shades	Principal Use
Acridine	>C=N-and>C=C	1,000	Textiles and Leather
Aminoketone	O=C-HN2	1,000	Intermediate
Anthraquinone	>C=O and>C=C	15,000	Textiles
Azine	-C-N=C-		
	-C-N-C-	1,000	Textiles and Leather
Monazo	One -N=N	9,000	
Disazo	Two -N=N-	9,000	
Azo Trisazo	Three -N=N	5,000	Textiles
Polyazo	Four or More -N=N-	2,000	
Azoic	-N=N	3,000	Textiles
Diphenylmethane	>C=N	1,000	Textiles
Hydroxyketone	0=C -OH	1,000	Intermediate
Indamine	two)C=N	300	Intermediate
Indigoid	O=C-C=C-C=O	1,000	Textiles
Indophenol	>C=N-and>C=O	300	Color Photography
Lactone	>C=O	1,000	Wool
Methine	>C=C	1,000	Paper and Photography
Nitro	-NO2	700	Textiles
Nitroso	-N=O =N-OH	300	Textiles
Oxazine	-C-N=C =C-O-C=	1,000	Calico printing
Phthalocyanine	>C=N	1,000	Paper
Quinoline	>C=Oand>C=N	1,000	Paper and Wool
Stilbene	-N=N-and>C=C	1,000	Cotton
Sulfur	=C-S-0= =C-S-S-0=	2,000	Textile
Thiazole	>C=N-and-S-0=	400	Intermediate
Triarylomethane	>C=AR=NH	3,000	Cotton, Silk, Wool

	>C=AR=O		
Xanthene	-O-C6H4-0	1, 000	Cotton, Silk, Wool

Appendix D

Vocabulary

Acid—any compound that reacts with a base to form a salt, produces hydrogen ions, turns blue litmus paper red

Alum—used in medicine and in making dyes

Anthracene—a product of coal-tar distillation used in making dyes and as a radiation detector

Azoic—contains the nitrogen radical -N:N(azo dyes)

Bast—fiber obtained from phloem

Bice—a grayish blue, duller than azure

Carotene—any of three red or orange-colored hydrocarbons

Chrome—any of certain salts of chromium, used in dyeing and tanning

Cloth—a woven, knitted, or pressed fabric of fibrous material, as cotton, wool, silk, hair, synthetic fibers, etc.

Colorant—anything used to give color to something else; pigment, dye, etc.

Cyan—blue (containing cyanogen)

Elastomer—a rubberlike synthetic polymer, as silicone rubber

Hemp—a tall Asiatic plant having tough fiber in its stem

Kermes—the dried bodies of certain Mediterranean insects, used to make a purple-red dye; the dye

Solubilized—the condition or extent of being soluble; the amount that can be solubilize

Tint—a delicate color or hue; tinge; a color or shading of a color

Twig—a small branch or shoot of a tree or shrub

Tyrian—a purple or crimson dye used by the ancient Romans and Greeks; bluish red

Teacher Bibliography

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Hoss, Norman, *The How and Why of Cloth Dyeing* . Columbus, Ohio: Charles E. Merrill Books, Inc. 1960.

Posin, Ean Q., *Out of this World* . New York: Popular Mechanics Press, 1959.

Zim, Herbert, and Baker, Robert H., *Stars* New York: Golden Press, Inc., 1956.

Student Bibliography

Baum, Allyn, *Stencil Art* : New York: Doubleday and Company, Inc., 1952

This book has illustrations and information relative to the designing of stencilling. There are patterns and directions how to do them. It also gives directions how to make your own.

Sharp, Robert P., *The Vocabulary of Coloring Cloth* . Oregon: University of Oregon Press, 1960.

This book gives hands on assignments that can be duplicated and discussed in class. There are personal assignments for various age and learning abilities.